WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Review on Reducing Weight of the Modern Bicycle

Prof. Vijay Jaysingrao Khot [1], Prof Prasad Ramchandra Kulkarni [2]

[1,2] **Associate Professor, Dr J J Magdum College of Engineering, Jaysingpur 416101**
E-mail: [1] vijay.khot@jjmcoe.ac.in, [2] prasad.kulkarni@jjmcoe.ac.in

ABSTRACT :

In todays world where more and more research is going to find out the more fuel efficient transportation Vehicles. Here one of the transportation vehicle is bicycle. This bicycle should be efficient with less power consumption. The power consumption is human muscle power. Here by reducing the weight of the bicycle will cover more distance in same human muscle power. The advancement in the field of ergonomics plays vital role in doing so. The developments on design and power transmissions have also reduce the weight of the bicycle.

Keywords: Material frames, chain stays, Paddle, Hub, Transmission systems.

1. INTRODUCTION

Today the biggest environmental problem is pollution. The major emission of harmful pollutants like carbon-monoxide, carbon-dioxide, and the unburnt hydrocarbons are affecting our ecosystem. So, in this era of such advanced technology, we should focus on coming up with sustainable solutions for the existing pollution causing technologies. To make a small start, we can concentrate on our transportation system and work on it. One of the transportation system is bicycle. This review paper is a sincere effort to focus on reducing weight by considering the modern-day advancements in the field of designing bicycle and its aspects. It covers all the topics involved in the design of a modern-day bicycle right from design considerations for frame, materials, alternative transmission systems, design of e-bike and its considerations along with calculations involved in component selections and finally including recent advancement in the wheel design. While compiling this review paper we have studied many papers to the understand the selection criteria for the material and different parts of bicycle. We also studied different transmission systems like shaft driven, gear driven, transmission on the idea of treadmill and electrically assisted bicycles. The point of attraction in new age bicycles is the spoke less and the Centre less wheeled bicycles. It brings major effect for reducing weight in modern day bicycles.

2. LITERATURE REVIEW

1. Weight Reduction Case Study of crank :

Sean Sullivan from Chris Huskamp, IBC Advanced Alloys (2013) discussed the case study of weight reduction of a premium road bicycle crank arm set by implementing Beral cast 310. The first part of the study concerns the direct substitution of 7050-T651Al with Beralcast 310. As mentioned previously, the crank arms are hollow forgings but the internal geometry is not known and was therefore not modeled. Graph outlines the final results of the substitution of Beralcast 310. The focus is on the relative differences between the two materials, therefore all of the results are shown as a percent difference. The figure 2.2 shows the graphical representation of weight reduction of existing crank. This study explores the Shimano Dura-Ace crank set in the following manner:

- Produce 3D CAD models of both crank arms.
- Perform FE analysis on the crank arms based on the standard 7050-T651 aluminum; this establishes a baseline strength and weight.
- Substitute the 7050-T651 Al with extruded Beralcast 310 alloy and observe the improvements in displacement and weight over the baseline figures.
- Show the potential weight savings by creating alternative versions of straight arm and compare them to the measured weight of the part.

2. Stress Analysis of Bicycle Paddle :

S. Abey Gunasekara and T.M.M. Amarasekara discussed the stress analysis of bicycle paddle and optimized by finite element method, describes and proposed improvements of designs with regard to minimize the weight, cost and optimum factor of safety. Failure of paddle crank means the progressive of sudden deterioration of their mechanical strength because of loading effect. Paddle make materials shown different properties as a result many advantages as well as disadvantages. However material strength should have ability to withstand an applied stress without failure. Generally, cranks are

manufactured of an aluminum alloy, titanium, carbon fiber, chromyl steel or other less expensive steel. The pedal force is changing every second in the process of turning the pedal and magnitude and direction of pedal force is different according to different riding posture. First half of the round pressure is positive and second half pressure is negative. Maximum load is coming vertically downward and magnitude is depending on the road condition, slope of the road and as well as weight of the rider. In this literature considered 95 % man's weight of the population is about 116Kg. This is the maximum load acting on pedal as well as crank in downward. Due to this load bending stress in crank and it will create twisting of the crank. The maximum bending stress gives the load acting at the end of the pedal. From this literature, we found that there is a maximum stress in sharp edges in the crank near to fixed hole so need to apply some fillets on sharp edges and more thickens near to fixed hole than the pedal fixing hole by adding material. Always it is needed to keep equivalent stress as much as low. It will benefit to durability of the component.

3. 19 W H Tan et al 2021 studied that how the changing of material of the bicycle frame and the insertion of the suspension system can reduce vibration. This study was conducted using aluminium alloy as the material for bicycle frame to reduce the vibration and the weight of the bike. The suspension system has also been customized into the bicycle frame as the main vibration absorber. The CAD model was developed and been analyzed using static and dynamic analysis based on the specific boundary condition. The static and dynamic analysis of bicycle frame was analyzed based on the specific boundary condition of adult's weight of 76 kg. Both static and dynamic analysis of bicycle frame were done using aluminum alloy as the material for the frame. The vibration analysis was conducted using dynamic analysis to obtain the six modes of frequency. The result showed a small deformation occurs on the frame that causes the frame to deflect from the original shape as depicted in modal analysis. Overall, it is concluded that a suspension system adopted on the bicycle frame can have a significant enhancement in vibration reduction on the rider. Although the deformation occurs, the bicycle frame can still absorb the tested vibration without the large deformation on the frame structure. The results are still acceptable and can be improved by future researchers to increase the thickness of the frame.

4. The same. The mountain bike frame in magnesium alloy is designed, and analyses under different parameters and the results are noted, and this shows lesser deformation than the traditional mode

Nair Ajit et al 2018 replaced bicycle frame material with magnesium alloy (AZ91D) and performed the analysis such as FEM, structural, static analysis, dynamic analysis and report the deformation under different loading conditions, and ensured the implementation of modified mountain bike frame with magnesium AZ91D alloy. The bicycle frame is designed by using CREO PARAMETRIC 3.0 and the analysis of the bicycle frame is done by using ANSYS software tool. A modified mountain bike frame model was created to simulate the behaviour of the frame under a range of measured load cases. The various analysis are performed under different loading conditions, structural analysis in both static and dynamic conditions are taken, highly stressed areas correlate reasonably well in terms of being similarly located with those simulations presented in the literature for similar load 21 cases, although our values tend to be somewhat lower than the existing model. This model is suited for off road conditions and best in on road conditions. By this model the frame weight is reduced and the other structural properties remains.

5. Chien-Cheng Lin, Song-Jeng Huang Chi-Chia Liu analyzed the stress and optimized the design of a customized bicycle frame using Pro/ENGINEER digital solid modeling computer-aided design software. It also attempts to verify the stress and displacement response of several bicycle frames using a wireframe model and then analyze the solid structure. It was found that, for a shell-entity frame, the diamond-type frame (diamond shaped) has the highest rigidity, and the mechanical properties of AZ60/Al2O3p magnesium metal matrix nano composites by equal channel angular extrusion almost acquire the level of Al6061 aluminium. For the mountain bike (MTB) frame simulated with ECAEed AZ61/Al2O3 MMCs, the calculation results show that not only is the rigidity similar to that of Al6061 but also compared to Al6061 aluminium alloy, the weight can be reduced from 4.0123 to 2.5764 kg (a weight reduction percentage of 36%). It is a bicycle frame of optimum size with lightweight in compliance with structural rigidity requirements.

6. Amareswari Reddy et al found that in design, it should be considered many factors such as product design must be satisfied by the customer, the material used the ability of the 22 product to work, and others. All part of the design is to fulfill customer need. Besides, that design will have an effect on the Company such as profit, loss, and reputation of the company. In this paper, they have modeled a diamond frame of the bicycle.

CONCLUSION FROM THE LITERATURE REVIEW:

From the review of literature presented above, the following are the major conclusions:

Weight reduction of frame and Chain stay helps the serious cyclist and racers for fast driving. A weight reduction of 02 Kgs will make the full proof design. Weight reduction means the rider can obtain greater speeds and distances using less energy.

3. DESIGN PROCESS

The five steps for solving the design problems are:

1) Define the Problem

2) Gather Pertinent Information

3) Generate Multiple solutions

4) Analyze and select a Solution

5) Test and Implement the Solution

Problem Definition :

The first step in the design process is problem definition. This definition usually contains a listing of the bicycle parts and specially information about parts functions and features .. Here in this paper we define the problem as bicycle weight reduction weight .

Gather Pertinent Information :

In the next step, relevant information for the design of the parts and its functional specifications is obtained. A survey regarding the availability of similar products in the market should be performed at this stage. We gathered relevant information about our project from various literatures.

Generate Multiple Solutions :

We generated multiple solutions. They are following as

1. Direct Material Substitution

2. Weight Reduction by Profile Design Change

3. Method of Manufacturing

In direct material substitution, In weight reduction, in addition to the material substitution a slight design modification on major two part 1. Frame 2 Chain Stay .

Analyze and Select a Solution

Considering cost, safety, and other criteria for selection, the more promising alternatives are selected for further analysis. Detail design and analysis step enables a complete study of the solutions and result in identification of the final design that best fits the product requirements. Here the bicycle 1. Frame 2 chain stay design is to be modeled on various design software like Pro-E, Solid Works, CATIA, etc. The design can be analyzed using ANSYS software.

Test and Implement the Solution

Following this step, a prototype of the design is constructed and functional tests are performed to verify and possibility to modify the design. Analyzed design can tested with market product and identify the advantages and disadvantages when compared with existing product. Tested solution to be implemented and receive the feedback from end user for future design improvements.

RESULT AND DISCUSSION

- Various literature surveys on design of bicycle frame and Chain Stay have been reviewed in this report and finally an optimum design of bicycle has been found out
- It has been found out the study presented come up with reliable results as well as safe design of bicycle frame and chain stay under permissible limits of various parameters and safe stresses
- Various literature surveys on material substitution for bicycle frame and chain stay have been reviewed in this report
- Current work has to be concluded up with the fact that slight and careful variation in design parameters gives a significant design which can be made feasible by a number of analysis using CAE tools and software.

CONCLUSION :

- Weight reduction of frame and chain stay helps the serious cyclist and racers for fast driving. A weight reduction by Aluminum alloy and carbon fiber of 02 Kgs will make the design be attractive .
- In reference to bicycle frame and chain stay weight and stiffness are both important characteristics. Weight reduction means the rider can obtain greater speeds and distances using less energy.

REFERENCES :

[1] Sean Sullivan (2013), “Weight Reduction Case Study of a Premium Road Bicycle Crank Arm Set by Implementing Beralcast 310”

[2] S. Abeygunasekara, T.M.M. Amarasekara, “Stress Analysis of Bicycle Paddle and Optimized by Finite Element Method”

[3] V. Sarath Teja, D.V.S.S.S.V. Prasad, K.S.B.S.V.S. Sastry, “Numerical Study on materials and Design Optimization of a Bicycle Frame”

[4] Lessing, Hans Erhard, “The evidence against Leonardo’s bicycle,” Cycle History, San Francisco, 1998, pp. 49-56.

[5] “Canada Science and Technology Museum: from Draisienne to Dandyhorse,” Retrieved 2008, pp. 12- 31.

[6] David Gordon Wilson “Cycle History”, Proceedings of the International Cycling History Conference (ICHC), vol. 1-18, 1990–2007.

[7] Pierre Lallement, “The original pedal-bicycle, with the serpentine frame,” US Patent No. 59915 drawing, 866.

[8] Herlihy, David,”Bicycle: the History,” Yale University Press, 2004, pp. 31- 62.

[9] www.thewheelmen.org/sections/faq/faq.asp#16

[10] Wu Y and Chan C 2018 A novel bicycle rear hub transmission with a magnetic gear mechanism *AME* **10 (7)** 1-9

[11] www.britannica.com/EBchecked/topic/64721/bicycle/230024/The-ordinary-bicycle, Retrieved 2008, pp. 05-15.

[12] Vignesh.M , Dr. Arumugam K , Vinoth.S, Hariharan.S, “DESIGN AND ANALYSIS OF FRAME OF AN ELECTRIC BIKE”(2019), International Journal of Engineering Science Invention (IJESI)