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Design and fabrication of bicycle enhancement

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ABSTRACT

Frame is very important part of bicycle as all the important accessories are mounting on the frame. The frame need to be very strong, stiff and light in weight, which is obtained by combining different materials and optimizing its shapes. The strength of frame construction is correct design of a frame because it is the most important part that ensures safe riding. This paper deals with the various design of bicycle frame. The modeling of bicycle frame is done in Computer Aided Design software CATI and analysis of frame is done using the analysis software Ansys. This analysis is done by considering conditions like static start up, steady state paddling, vertical impact, horizontal impact, rear wheel braking etc. This paper gives us the stress, strain, factor of safety of particular bicycle frame.

Keywords: CATIA, FEA, Ansys, Bicycle frame, Impact.

INTRODUCTION

A bikes frame is the central system to support and locate other components of the bicycle such as Chain-drive system, Handle bar and steering system, pedal assembly, seat. For a good performance of the bicycle various conditions have to be met such as stability, ride quality, ergonomics to rider etc. Bicycle seen today are 100 years old, with very few changes they still are important to many commutes. Now there are more than a billion bicycles worldwide, twice as many as an automobile it's not only a mode of transport but also is a recreational sport, form of physical exercise and the most clean and cheap transport. The basic shape and configuration of a typical upright, or safety bicycle, has changed little since the first chain-driven model was developed around 1885. But many details have been improved, especially since the advent of modern materials and computer-aided design. These have allowed for a proliferation of specialized designs for many types of cycling.

The bicycle's invention has had an enormous effect on society, both in terms of culture and of advancing modern industrial methods. Several components that eventually played a key role in the development of the automobile were initially invented for use in the bicycle, including ball bearings, pneumatic tires, chain-driven sprockets, and tension-spiked wheels.

The bicycle has undergone continual adaptation and improvement since its inception. These innovations have continued with the advent of modern materials and computer-aided design, allowing for a proliferation of specialized bicycle types.

A bicycle stays upright while moving forward by being steered so as to keep its center of mass over the wheels. This steering is usually provided by the rider, but under certain conditions may be provided by the bicycle itself. The combined center of mass of a bicycle and its rider must lean into a turn to successfully navigate it. This lean is induced by a method known as counter steering, which can be performed by the rider turning the with the hands or indirectly by leaning the bicycle.

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LITERATURE REVIEW

In recent years, Melissa Bopp (2018), active transportation (AT; i.e., walking and bicycling) has become recognized more frequently as a fundamental mode of transportation. In support of this recognition, domestic and foreign agencies alike have placed a strong emphasis on the promotion of AT and bicycling. In 2010, the United States Department of Transportation issued a policy statement calling for the collection of more data on AT modes. Although the majority of this book focuses pointedly on bicycling behavior, it is important to note the major literature gaps on measuring bicycling behavior separate from Derek Covill (2016), Bicycles are subject to a wide range of loads at various locations around the frame. The first published measurement of loads applied to a bicycle occurred in 1968 with Hoes et al measuring pedaling loads using strain gauges mounted on the pedal and crank of a bicycle ergometer. Davis (2016), recent concerns about the expenditure of energy for human transportation have accentuated the need for more efficient passenger vehicles. The result has been an unprecedented increase in the use of lightweight structural materials in the manufacture of automobiles in the United States. Another result has been the increased popularity of bicycles. For practical transport. M. N. V .Krishna Veni (2016), Design is important stage in manufacturing. It is because any product produced must be through design stage where in design stage consists of conceptual design, concept selection; identify customer need, concept selection, analysis and others. In design, it should be consider many factors such as product design must be satisfied by customer, material used the ability product to work and others. All part in design is to fulfill customer need. Chien-Cheng Lin (2017), as bicycles are environmentally friendly, safe and are a form of exercise with many other advantages, the government of Taiwan and the bicycle industry have promoting them as green products. Taiwan is a major producer of bicycles and their components and is a center for the development of manufacturing process technology and materials science. The appearance of a bicycle is no longer limited to the traditional style [6-8].

PROBLEM IDENTIFICATION

The main aim of this project is to design, engineer, and demonstrate a bicycle to carry a single person, with a price tag of Rs 2500/-, based on the sales of 50,000 units per year. It is developed for the users to rotate the back wheel of a two-wheeler. In this design we implemented the chainless transmission to the bicycle to overcome the various disadvantages of a chain drive. Usually in two-wheelers, chain and sprocket method is used to drive the back wheel but in this design the pedal is enough to drive the back wheel.

The other objectives are this design is documented by the way of complete manufacturing drawing of all the parts and assemblies, with individual costing along with the engineering material.

To convince a company to invest on manufacturing an optimized variant of this product after due certification by homologation authority of the country of manufacture. The ball bearing inclusion allows the rider to turn the back wheel slightly for the balance in turning. The chainless drive system provides smooth and efficient transfer of energy to the wheel.

METHODOLOGY

The methodology used in this paper consists of modeling the bicycle frame in CATIA software and analyze the frame using the analysis software Ansys. In this paper the sample analysis of frame of Falcon Avon is presented here. CATIA is software which is used for creation and modifications of the objects. In CATIA, the design and modeling feature is available. Design means

the process of creating a new object or modifying the existing one. Drafting means the representation or idea of the object. Modeling means creation 2D to 3D model. By using CATIA software, create the model of the bicycle frame. The modeling of various frames in CATIA is as follows.

Demonstrate a bicycle to carry a single person, with price tag of Rs 2500/-.Chain transmissions difficult to assembling and disassembling. The chain in the transmission system may get loosen frequently. Using chainless transmission to the bicycle. Analyzing the bicycle we designed with the of ansys software.

DESIGN

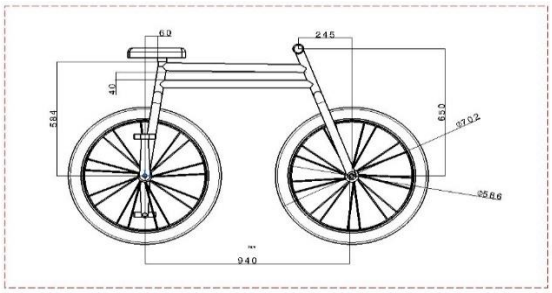

Fig. 5.1 Front view of bicycle

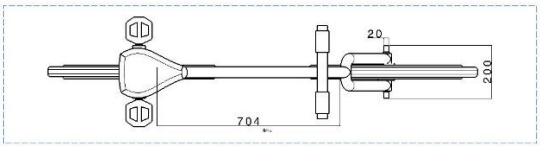

Fig. 5.2 Top view of bicycle

The bicycle frames donated for fatigue investigation feature a traditional diamond frame design, consisting of a front and rear triangle. This design has been the industry standard for bicycle frame design for over one hundred years. The frame consists of a top tube, down tube, head tube, seat tube, seat stays, and chain stays. The head tube of the frame holds the steer tube of the fork, which in turn holds the front wheel.

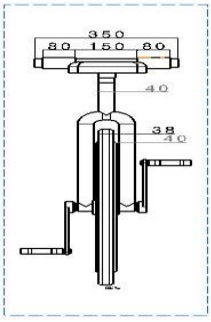

Fig. 5.3 Side view of bicycle

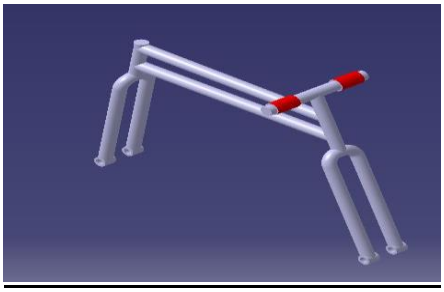

Fig. 5.4 3D Frame Model

Table I

Part name	Dimensions
Rim	26-1.95
Tier	Based on rim
Frame	Diameter-40(1.5”)
Handle bar	350
Seat height	584,60
Handle bar height	650,245

After modeling the analysis of frame is done in Ansys Software, for that purpose After preparing the model in CATIA it is improved to ANSYS, the file is imported from CATIA by file>import>IGES. To carry out the analysis various conditions are consider like, Static start up, Steady state pedaling, Vertical impact, Horizontal impact, Rear wheel braking. The input data for the analysis of bicycle frame Material IS2039 is as follows:

Young’s modulus: 2.e+005 MPa
Poisson’s ratio = 0.31
Density = 7.75e-006 kg/m3
Tensile Yield Strength =320 MPa
Tensile Ultimate Strength= 400 MPa
Physics type = Structural
Analysis type= Static structural, Solver target= Ansys mechanical

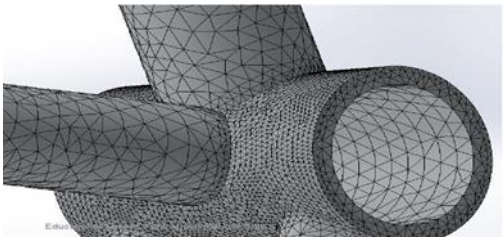

Fig. 5.4 Meshing

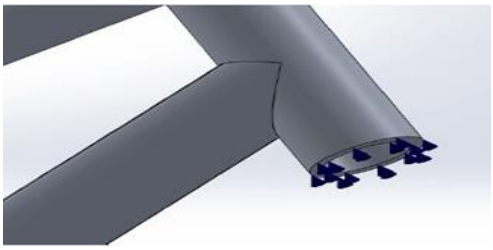

Fig. 5.5 Constrains

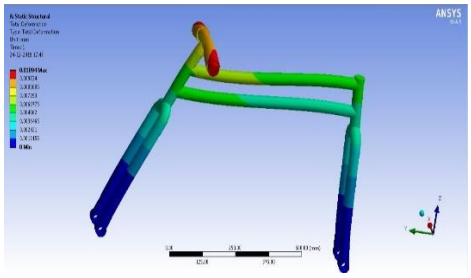

Fig. 5.6 CAE report of frame total deformation

Calculation:

Where
P=Load Applied =200N
L=Length of the Beam = 500mm
B=Breadth of the Pipe
H=Height of the Beam
E=Young Modulus

Bending Moment

$M=P*L = 200*940 = 188 \text{ X } 10^3$ N/mm.

Moment of Inertia

$I = (BH^3-B_1H_1^3)/12 = (1.29*650^3-1.20*584^3)/12 = 811 \text{ X}10^3$ mm^4.

Maximum Deflection

$\delta=PL^3/3EI = (200*940^3/3*2e^5*81e^3) = 0.02$ mm.

Result Comparison

Result	Deflection (mm)
Analytical	0.0109
Theoretical	0.02

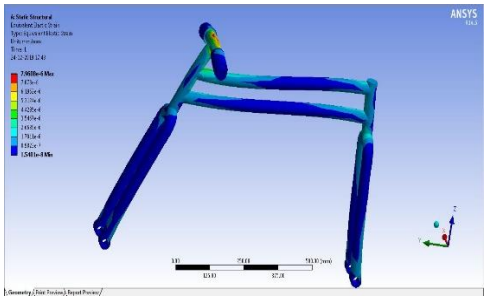

Fig. 5.7 CAE report of frame Equivalent elastic strain

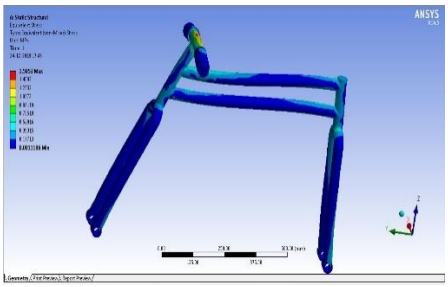

Fig. 5.8 CAE report of frame equivalent stress

Max. Stress

$\sigma_{max} = 6PT/BD^2 = (6*205*5)/(1.29*5.08^2) = 1.84$ N/mm^2.

Result Comparison

Result	Max Stress(N/mm$^{2)}$
Analytical	1.58
Theoretical	1.84

Fig. 5.9 Bicycle

CONCLUSION

This design is fully based on the idea of replacing chain drive model cycles and we try our hard to achieve it. This design has the advantage of carrying from one place to another by a single person. The design also provides new way of riding a bicycle.

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