Loop wheel bicycle

Shubham Bankar

Guided by Professor, Department of Mechanical Engineering

Abstract: A Loop wheel is a wheel with integral suspension, designed for higher shock-absorbing performance and better comfort. Loop wheels offer you a smoother ride. They're more comfortable than usual wheels: the carbon springs absorb exhausting vibration, in addition to the bumps and the shocks. They're extraordinarily robust and durable. Material used for manufacturing loop wheel springs is composite material which carefully developed to offer ultimate compression and lateral stability as well as durability. Specially-designed connectors attach the springs to the hub and rim. The three loops in every wheel work along as a self-correcting system. This spring combination between the hub and the rim of the wheel provides better suspension that steadily adjusts to uneven terrain cushioning the rider from abnormalities in the road. In effect, the hub floats inside the rim, adjusting continuously as shocks from the uneven road hit the rim of the wheel. The spring configuration permits the torque to be transferred smoothly between the hub and the rim.

Keywords: Loop wheel, springs, hub and rim, shocks

INTRODUCTION

A wheel is a circular part that's meant to rotate on an axle bearing. The wheel is one of the essential parts of the wheel and axle which is one of the six simple machines. Wheels, in conjunction with axles, enable heavy objects to be moved simply facilitating movement or transportation while supporting a load, or performing labour in machines. Wheels are also used for various alternative functions, such as a ship's wheel, steering wheel, potter's wheel and flywheel. Common examples are found in transport applications. A wheel greatly reduces friction by facilitating motion by rolling along with the use of axles. For the for wheels to rotate, a moment has to be applied to the wheel about its axis, either by means of gravity, or by applying another external force or torsion.

Recent Advancements in cycles

Track bicycle
A track bicycle or track bike is a bicycle optimized for racing at a velodrome or outdoor track. Unlike road bicycles, the track bike is a fixed-gear bicycle; thus, it has only a single gear ratio and has neither a freewheel nor brakes. Tires are narrow and inflated to high pressure to reduce rolling resistance. Tubular tires are most often used in track racing and training, though advances in clincher tire design have seen them being used somewhat more often.

Racing bicycle
A racing bicycle, also known as a road bike, is a bicycle designed for competitive road cycling, a sport governed by according to the rules of the Union Cyclist International (UCI). The UCI rules were altered in 1934 to exclude recumbent bicycles.
The most important characteristics about a racing bicycle are its weight and stiffness which determine the efficiency at which the power from a rider's pedal strokes can be transferred to the drive-train and subsequently to its wheels. To this effect racing bicycles may sacrifice comfort for speed. The drop handlebars are positioned lower than the saddle in order to put the rider in a more aerodynamic posture.

Problem statement

In the conventional bicycles there no any type of suspension system. The spokes attached to rim has less load bearing capacity for special purpose cycles. The aim of the project is to design new type of wheel with hub, rim and tyre to provide suspension as well as to support rim and provide better bearing capacity.

Objective of the project

1)   To design better shock-absorbing performance.
2)   To give smoother ride.
3)   To increase load bearing capacity.

Future scope

In this project we will design and fabricate a loop-wheel bicycle which will be able to have extra feature of shock absorption and also the better load bearing capacity. The project will contain a bicycle with an improved wheel. The wheel will be replaced from conventional spoked-rim system to leaf spring or loop spring. The wheel will consist Axle, Hub, Rim, Tyre and Leaf/loop springs. All parts will be mounted in wheel so as to maintain its centre of gravity.

LITERATURE REVIEW

GulurSiddaramanna, Shiva Shankar[1], the automobile industry has shown increased interest in the replacement of steel spring with fibreglass composite leaf spring due to high strength to weight ratio. Therefore; the aim of this paper is to present a low cost fabrication of complete mono composite leaf spring and mono composite leaf spring with bonded end joints. Also, general study on the analysis and design. A single leaf with variable thickness and width for constant cross sectional area of unidirectional Glass Fiber Reinforced Plastic (GFRP) with similar mechanical and geometrical properties to the multileaf spring, was designed, fabricated (hand-layup technique) and tested. Computer algorithm using C-language has been used for the design of constant cross-section leaf spring. The results showed that an spring width decreases hyperbolically and thickness increases linearly from the spring eyes towards the axle seat. The finite element results using ANSYS software showing stresses and deflections were verified with analytical and experimental results. The design constraints were stresses (Tsai-Wu failure criterion) and displacement. Compared to the steel spring, the composite spring has stresses that are much lower, the natural frequency is higher and the spring weight is nearly 85 % lower with bonded end joint and with complete eye unit.

Pankaj Saini, Ashish Goel and Dushyant Kumar [2], as reducing weight and increasing strength of products are high research demands in the world, composite materials are getting to be up to the mark of satisfying these demands. In this paper reducing weight of vehicles and increasing the strength of their spare parts is considered. As leaf spring contributes considerable amount of weight to the vehicle and needs to be strong enough, a single composite leaf spring is designed and it is shown that the resulting design and simulation stresses are much below the strength properties of the material satisfying the maximum stress failure criterion.

Baviskar A. C., Bhamre V. G. And Sarode S. S[3], analysis of leaf spring. The suspension system in a vehicle significantly affects the behaviour of vehicle, i.e. vibration characteristics including ride comfort, stability etc. Leaf springs are commonly used in the vehicle suspension system and are subjected to millions of varying stress cycles leading to fatigue failure. A lot of research has been done for improving the performance of leaf spring. Now the automobile industry has shown interest in the replacement of steel spring with composite leaf spring. In general, it is found that fibreglass material has better strength characteristic and lighter in weight as compare to steel for leaf spring. In this paper there is reviewed some papers on the design and analysis leaf spring performance and fatigue life prediction of leaf spring. There is also the analysis of failure in leaf spring. Also the analysis of leaf spring with ansys is done. The automakers can reduce product development cost and time while improving the safety, comfort, and durability of the vehicles they produce.
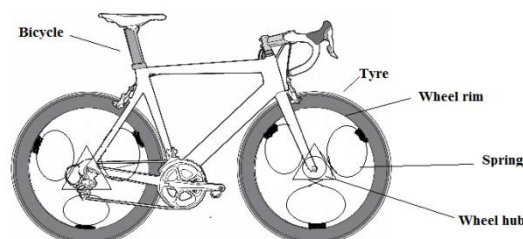
Schematic diagram of Loop wheel bicycle setup

Figure.1. Loop wheel bicycle setup

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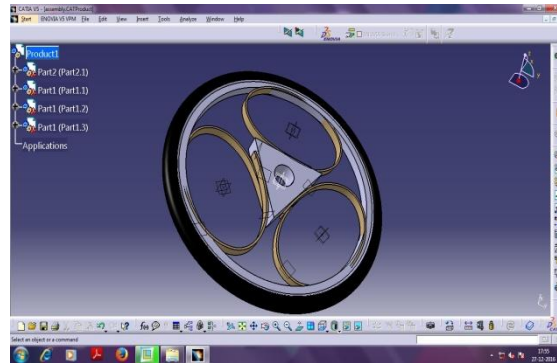Vol. 5, Issue 11, November 2018

3D model of setup

Figure.2. Catia model of Loop wheel

Components Used
Bicycle
A bicycle, often called a bike or cycle, is a human-powered, pedal-driven, single-track vehicle, having two wheels attached to a frame, one behind the other. A bicycle rider is called a cyclist, or bicyclist.

Tyre
A tire or tyre is a ring-shaped covering that fits around a wheel rim to protect it and enable better vehicle performance by providing a flexible cushion that absorbs shock while keeping the wheel in close contact with the ground. The word itself may be derived from the word "tie," which refers to the outer steel ring part of a wooden cart wheel that ties the wood segments together.

Wheel Rim
The rim is commonly a metal extrusion that is butted into itself to form a hoop, though may also be a structure of carbon fiber composite, and was historically made of wood. Some wheels use both an aerodynamic carbon hoop bonded to an aluminium rim on which to mount conventional bicycle tires. A bicycle wheel is a wheel, most commonly a wire wheel, designed for a bicycle.

Leaf Spring/Loop Spring
A leaf spring is a simple form of spring commonly used for the suspension in wheeled vehicles. Originally called a laminated or carriage spring, and sometimes referred to as a semi-elliptical spring or cart spring, it is one of the oldest forms of springing, dating back to medieval times. A leaf spring can either be attached directly to the frame at both ends or attached directly at one end, usually the front, with the other end attached through a shackle, a short swinging arm.

Triangular Wheel Hub
A Triangular hub is the centre part of a bicycle wheel. It consists of an axle, bearings and a hub shell. Hub shells can be one-piece with press-in cartridge or free bearings or, in the case of older designs, the flanges may be affixed to a separate hub shell. The hub is the centre of the wheel, and typically houses a bearing, and is where the axle is mounted inside it.A hub less wheel (also known as a rim-rider or centerless wheel) is a type of wheel with no centre hub

Calculation
LEAF SPRING
Calculations
Distribution of body weight for average weight of 60 kg per person

$$\text{Head} = \frac{8.26}{100} * 60 = 4.956 \text{ kg}$$

$$\text{Thorax} = \frac{20.1}{100} * 60 = 12.06 \text{ kg}$$

$$\text{Abdomen} = \frac{13.06}{100} * 60 = 7.836 \text{ kg}$$

$$\text{Pelvis} = \frac{13.66}{100} * 60 = 8.196 \text{ kg}$$

$$\text{Total arm} = \frac{5.7}{100} * 60 = 3.42 \text{ kg}$$

$$\text{Thigh} = \frac{10.56}{100} * 60 = 6.3 \text{ kg}$$

Total effective weight Distribution in combination

$$\textbf{Head \& Neck} = \frac{6.81}{100} * 60 = 4.086 \text{ kg}$$

$$\textbf{Trunk} = \frac{43.02}{100} * 60 = 25.81 \text{ kg}$$

2* total arm$= \frac{4.715}{100} * 60 = 2.829*2 = 5.658$ kg

2* thigh $= \frac{14.47}{100} * 60 = 8.68*2 = 17.364$ kg

Total effective weight = 4.086+25.81+5.658+17.364

= 52.918 Kg

Now calculation for total load on each wheel
As we know that the total weight if get distributed on two wheels
And total approximate weight of cycle = 14 Kg
Hence load on each wheel, w = 30 kg + 7 kg = 37*9.81 = 362.97 N
Load due to tractive force, f = μ * w = 0.02 * 362.97 = 7.2594 N
Total load on each wheel, F = w + f = 362.97 + 7.2594 = 370.2294 N

Chain design
Selecting standard chain used in cycle as Chain -06 B
Pitch -9.525mm
1.   Roller diameter,d_1=6.35 mm
Width' b_1=5.72 mm
Transverse pitch p_t=54.85 mm
z_1= 18
z_2= 44
2.   Approximate centre distance,
a = 40*P ----------------nominal
a = 40*9.525
a = 381 mm
3.   No of links,
$$L_n = 2(a/p) + \left(\frac{z1+z2}{2}\right) + \left(\frac{z2-z1}{2\pi}\right) * \left(\frac{p}{a}\right)$$
$$= 2(381/9.525) + \left(\frac{18+44}{2}\right) + \left(\frac{44-18}{2\pi}\right) * \left(\frac{9.525}{381}\right)$$
$$= 111.10 = 111$$

Leaf Spring
Calculate maximum stress
We used C20 material
Tensile strength=560N/mm^2
σ max of C20 material=560/2=280 N/mm^2
Given data:
F=370.22N
Major Axis of loop spring=L=300mm
Minor axis of loop spring=h=200mm
E= 200MPa
Width of spring=b=25.4mm
Thickness of spring=t=5mm
$$\sigma \text{ max} = \frac{3FL}{2nbt^2}$$
$$= \frac{3*370.22*300}{2*1*25.4*5^2}$$
$$= 262.36 \ N/mm2 < 280 \ N/mm2$$
Hence design safe.
II. Calculation of max. Deflection:
$$\delta\text{max} = \frac{3FL^3}{8Enbt^3}$$
$$= \frac{2*370.22*300^3}{8*2*10^5*1*25.4*5^3}$$
$$= 5.90 \text{ mm}$$

COST ESTIMATION

Cost estimation may be defined as the process of forecasting the expenses that must be incurred to manufacture a product. These expenses   take into a consideration all expenditure involved in a design and manufacturing with all

related services facilities such as pattern making, tool, making as well as a portion of the general administrative and selling costs.

PURPOSE OF COST ESTIMATION

1. To determine the selling price of a product for a quotation or contract so as to ensure a reasonable profit to the company.
2. Check the quotation supplied by vendors.
3. Determine the most economical process or material to manufacture the product.
4. To determine standards of production performance that may be used to control the cost.

SAFETY PRECAUTIONS

The following points should be considered for the safe operation of machine and to avoid accidents:-
- All the parts of the machine should be checked to be in perfect alignment.
- All the nuts and bolts should be perfectly tightened.
- The operating switch should be located at convenient distance from the operator so as to control the machine easily.
- The inspection and maintenance of the machine should be done from time to time.

Advantages:
1) Better shock-absorbing performance.
2) Greater comfort.
3) Smoother ride.
4) More comfortable than standard wheels.
5) They are extremely strong.

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