

Design & Analysis of Loop wheel Bicycle

Yogeshwar More¹ Naipunya Patil² Kunal Patil³ Mayuresh Pore⁴ Abhishek Pund⁵

¹Assistant Professor, Department of Mechanical Engineering, PESMCOE Pune-05, Maharashtra, India.

^{2,3,4,5} U.G. Student, Department of Mechanical Engineering, PESMCOE Pune-05, Maharashtra, India.

ABSTRACT

In today's world, Bicycles are the most favourite choice when it comes to causes like health, pollution, and environment. Researches have been done in order to make the ride comfortable. This undertaking report introduces the Loop wheel. The purpose of our project was to reduce shocks on uneven roads, improve shock Absorption & take a smooth ride. Loop Wheel is a suspension system, Built to Experience smooth ride on uneven road by reducing shocks! So we replaced Spokes by 3 carbon springs. If we are riding on uneven road, the spring can move in between Hub and Rim. As its gone pass by a bump or bad road then the spring which is been touched to the surface will get compressed and others get expand! So the whole impact power gets distribute in the wheel and the rider will feel nothing about that impact. They're very sturdy and durable. They are more leisurely than traditional wheels. The spring design allows the torque to be exchanged easily between the centre point and the edge. In this project report loop wheel manufactured using C20 steel material and the analysis is done on ANSYS Workbench R15 to determine the stress developed during forces acting on wheel, maximum deflection, principle stresses.

KEYWORDS: Elliptical leaf spring, Suspension system, Loop wheel, Triangular hub, ANSYS R15

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I. INTRODUCTION

Loop wheels: because sometimes it's good to reinvent the wheel -Loop wheels are a new type of bicycle wheel that have been designed to make cycling more comfortable. Loop wheels feature this spring framework between the centre and the edge of the wheel gives suspension that consistently acclimates (adapt) to uneven landscape padding the rider from anomalies (expected) in the street wheel. The spring arrangement allows the torque to be exchanged easily between the centre point and the edge.

Front and rear Loop-wheels have different spring rates. A front and rear loop-wheel can be used together as a set, or you can use a single loop-wheel alongside a conventional spoke wheel. Loop-wheels provide suspension on a bike which has none, or can be fitted in addition to suspension forks to give a smoother, more comfortable ride.

The Loop wheels are a new concept wheel for a bicycle. The spokes of a conventional wheel have been replaced with carbon fibre loops which not only attach the outer rims to the centre hub, they also provide suspension. The result is maximum comfort over bumps and less vibration from the road. Replacing the spoke wheels with Loop wheels provides full suspension in a bike which hasn't got room for a traditional suspension system, but each Loop wheel weighs only about 300g more than its spoke equivalent. Unlike suspension forks, which only work in one plane, Loop-wheels provide tangential suspension. That is, they work in every direction.

So they respond to a force hit head-on in the same way as they do to a force for above or below. By using loop wheel bicycle rider gets comfortable ride because Tangential suspension. Pedalling is much smoother and not as jerky, because the springs release energy more evenly. This makes for a very comfortable, easy ride.

1.1 Problem Statement-

In the conventional bicycles there less 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.

1.2 Objective

The objective of this project is to adapt new techniques while designing new type of wheel with Hub, Rim and tyre to provide and improve suspension of bicycle with good stability. Our aim behind this project is to give better shock absorbing performance, to give smoother ride, to expand load bearing capacity.

II. LITERATURE REVIEW

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Urgent Operational Requirement Build your own loop wheel -The Loop wheels are a new concept wheel for a bicycle. The spokes of a conventional wheel have been replaced with carbon fibre loops which not only attach the outer rims to the centre hub, they also provide suspension. The result is maximum comfort over bumps and less vibration from the road. Replacing the spoked wheels with Loop wheels provides full suspension in a bike which hasn't got room for a traditional suspension system, but each Loop wheel weighs only about 300g more than its spoked equivalent. Unlike suspension forks, which only work in one plane, Loop-wheels provide tangential suspension. That is, they work in every direction.

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Mono Composite Leaf Spring For Light Weight Vehicle Design, End Joint Analysis And Testing”
By Gulur Siddaramanna, Shiva Shankar, Sambagam Vijayarangan-Author says, A single leaf with variable thickness and width for constant cross sectional area of unidirectional glass fibre reinforced plastic (GFRP) with similar mechanical and geometrical properties to the multi leaf 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 a 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. 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.

2.1 Identified Gaps in the Literature

After referring available reference material, it is found that researcher do the work with composite material for making loop, in order to reduce the weight of Bicycle. For cost effective manner here decide to do the experimentation with large diameter wheel the change in material i.e. C20. One research paper found with C20 material but experimentation is done for smaller wheel diameter. Hence scope for Loop suspension system for large diameter wheel with material as C20.

III. WORKING PRINCIPLE

While using spoke wheels in day to day routing life wheel's shock absorption is very low and the rider can feel it. Loop wheel is the solution we can get some hope on. Loop wheel has three springs/strips which work as suspension system. The spring system of these three between cycle's hub and rim of the wheel provides constant suspension to uneven terrain and potholes in the road, cushioning the rider from bumps. The hub floats between the rim and adjusting constantly as bumps and shocks from the uneven surface hit the rim of the wheel. The strips arrangement allows the torque to be transferred smoothly between the hub and the rim. Each wheel has a regular hub with a hub brake and hub gearing. Instead of spokes however three looped carbon composite springs are placed onto the hub. Whenever the wheel hits a bump in the road, the energy is absorbed by that spring. We try to create loop wheel with considering the weightage of cycle and rider to be equally distributed over the wheels of the bicycle. Compression rate is kept same for each loop wheel to be designed.

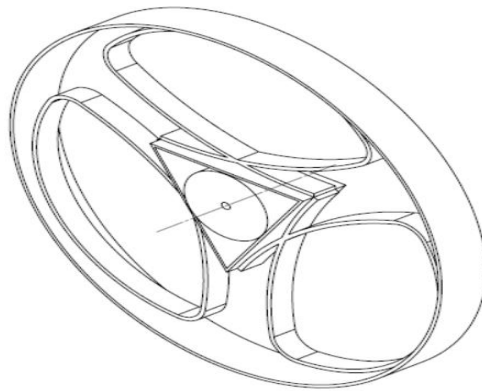


Fig 3.1 Loop Wheel

The invention of wheel has a great value when it came to as a load carrying device. Today the wheel is an essential part of most machines in the form of gears, pulleys, cams, sprockets, bearings, and other rotating devices. After so much time passed wheel is still most conspicuous as a load carrier and from a technical view, the bicycle wheel is one of the elegant one. More than a century ago world has been introduced by the wire spoked bicycle which replaces wooden wheels with thick and rigid spokes. By tensioning the wires, made that wheels possible and with this technique light weight vehicles are introduced to the world

Wire spoke genuinely make lot of difference in the wheels future. They not only reduced weight of the wheels but also improved durability. The wheels now can carry weights hundred times more than their own weight. Also in off-road bicycling, trained cyclist always has to face tons of obstacles with lots of forces acting on wheels from each side. But whoever tries to understand the mystery behind the unusual strength of bicycle are making bicycle ride more comfortable with making changes in suspension system. The big change is by introducing tangential suspension system in wheel itself which can absorb shocks from all the direction.

All shocks has to pass through the centre of the wheel i.e. Hub. In basic design of bicycle, hub is fixed with rigid spokes joined to rim which practically doesn't take any part in providing suspension. By understanding importance of hub, it has been given the ability to move back and forth. This is happening by replacing settled spokes with springs like material which has damping capacity. A spring made of metal bended like a leaf spring clamped individually utilized for the suspension.

IV. METHODOLOGY AND MATERIALS

The main target was to achieve the desired deflections in the suspension for a particular weight of driver. Considering the application C20 material is selected for loop. The thickness of the circle is controlled by accepting it to be a cantilever shaft and outlining it for bowing disappointment and the plan was then investigated in Ansys programming.

The firmness of the circle can be changed by basically moving the mounting places of the circle in the driver's seat's centre point end. By changing the effective length of the loop we can change the stiffness and hence control the hub travel.

The wheel was designed considering the impact forces coming from the ground and lateral forces while cornering. By checking the stresses and nature of deformation for 3 loops only. Using more number of loops will lead to unnecessary increase in weight. The analysis was done on Ansys v15.0 software to check the stresses and deformation in the system. A custom hub is designed to accommodate the entire loop with the help of nut and bolts.

V. LEAF SPRING CALCULATIONS

5.1) Material used-

5.1.1) Material used for spring: - C20 material

5.1.2) Material Properties:-

Tensile strength = 560N/mm²

E= 200MPa

$\sigma_{max} = 560/2=280$ N/mm²

5.2) Calculation for total weight on each wheel

Consider,

Weight of person = 70kg

Weight of cycle = 14kg
 Total weight on both wheel = weight of person + weight of cycle
 = 70+14
 = 84kg
 Total weight on each wheel = Total weight on both wheel / 2
 = 84/2
 =42kg

5.3) Calculation for total load on each wheel (F)

Load on each wheel due to weight = w = 42×9.81 = 412.02N
 Load due to tractive force = f = μ * w = 0.02 * 412.02 = 8.24N
 Total load on each wheel, = F = w + f
 = 412.02+ 8.24
 = 420.26 N

5.4) Calculation for dimension of loop spring

5.4.1) width (b) - The width of the leaf material was kept as 25.4mm as it cannot be more than the width of the wheel.

5.4.2) thickness (t)-

For determining the thickness of the Leaf, let us consider it as cantilevered

Major axis loop (L) =300mm (12inch)

Minor axis loop (h) =195mm (7.8inch)

$$\sigma_{max} = \frac{3FL}{2nbt^2}$$

$$280 = \frac{3 \times 420.26 \times 300}{2 \times 1 \times 25.4 \times t^2}$$

$$t = 5.4\text{mm}$$

5.5) Calculation of maximum Deflection

$$\delta_{max} = \frac{3FL^3}{8Enbt^3}$$

$$\delta_{max} = \frac{3 \times 420.26 \times 300^3}{8 \times 2 \times 10^5 \times 1 \times 25.4 \times 5.4^3}$$

$$\delta_{max} = 5.32\text{mm}$$

Above calculations were done considering half portion of spring hence total deflection would be = 5.32×2 = 10.64mm

VI. DIMENSION OF LOOP SPRING

PARAMETERS	VALUES
Total length of loop spring(L)	300 mm
Thickness of loop spring(T)	5.4mm
Width of loop spring(B)	25.4mm
Outer diameter of loop(D1)	254mm
Inner diameter of loop(D2)	250mm
Number of graduated loop wheel(n)	3

VII. CAD MODEL

We had used solid works 2018 to create and assemble the 3D model of Loop Wheel as shown below Solid works is a solid modelling computer-aided design (CAD) computer program. We can conceptualize, create, validate, communicate, manage & transform our ideas into great product designs.

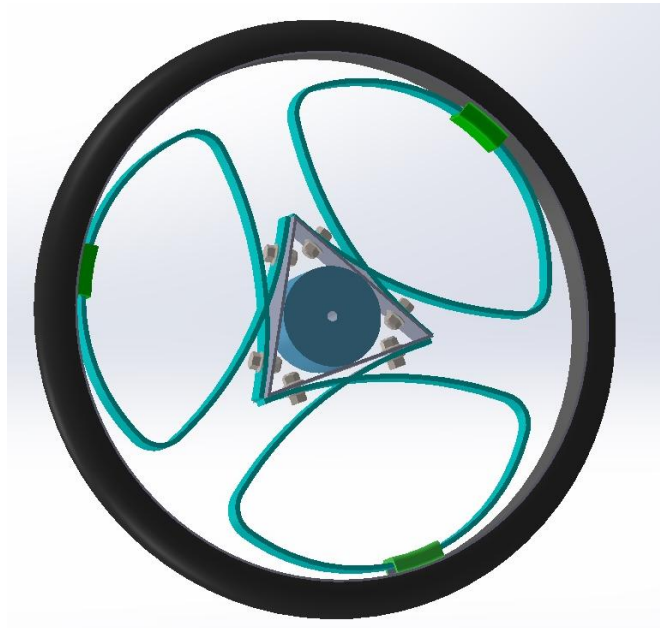


Fig 7.1 CAD Model

VIII. ANSYS RESULT

Analysis has been done on ANSYS Workbench 2020 R2 to determine the Maximum Deformation Results were obtained as follows:

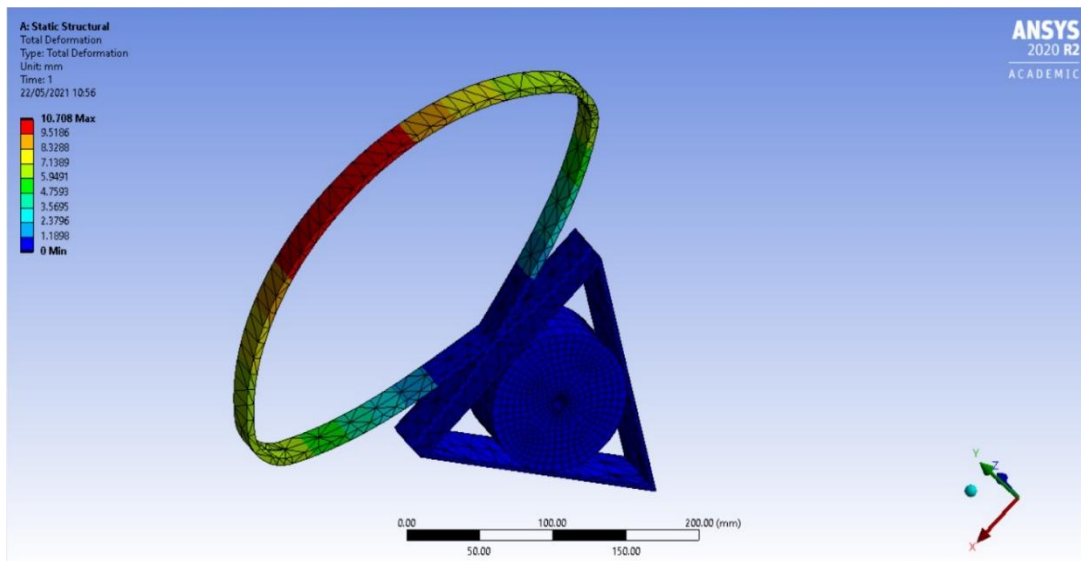


Fig 8.1 Deformation distribution

RESULTS FOR DEFORMATION		
	ANSYS	THEORETICAL
MAXIMUM DEFORMATION	10.708mm	10.64mm

Table 8.1 Deformation Result

IX. CONCLUSION

Bicycle with loop wheel suspension system provides smoother ride, high shock absorption capacity, avoids the necessity of additional suspension system. Also this loop wheels can find their applications in wheel chairs, mountain bikes because of their capacity to adjust to uneven terrain, cushioning the rider from

abnormalities in the road. Analysis on deformation has been done which shows that the calculated and the values obtained using ANSYS are in accordance with each other which suggest that the design is safe.

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REFERENCE

- [1]. Gulur Siddaramanna, Shiva Shankar and SambagamVijayarangan, “Mono Composite Leaf Spring for Light Weight Vehicle – Design, End Joint Analysis and Testing”, MATERIALS SCIENCE (MEDŽIAGOTYRA), ISSN 1392–1320, Vol. 12, Issue No. 3, 2006, PP 220-225.
- [2]. Pankaj Saini, Ashish Goel and Dushyant Kumar, “Design and Analysis of Composite Leaf Spring for Light Vehicles”, International Journal of Innovative Research in Science, Engineering and Technology, ISSN: 2319-8753, Vol. 2, Issue 5, May 2013, PP 1-10.
- [3]. Baviskar A. C. Bhamre V. G. and Sarode S. S. “Design and Analysis of a Leaf Spring for automobile suspension system- A Review”, International Journal of Emerging Technology and Advanced Engineering, ISSN 2250-2459, Volume 3, Issue 6, June 2013, PP 406-410.
- [4]. Info@Loop-wheels.com, An advertising poster, “Loop-wheels: because sometimes it's good to reinvent the wheel”