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Fabrication of Loop Wheel System.

Swapnil S. Loharkar[1], Ramchandra J. pawar[1], Yeshwant M.G.P Makarla[1], Ajinkya G. Sanap[1], M.B.Kumbhar[2]

[1*]*U.G. Students, Department of Mechanical Engineering, Sinhgad Institute of Technology, Lonavala, Maharashtra, India*
[2]*Asst. Professor, Department of Mechanical Engineering, Sinhgad Institute of Technology, Lonavala, Maharashtra, India*
[*]*swapnilloharkar123@gmail.com*

***Abstract*:** A Loop wheel is a wheel with integral suspension, designed for better shock-absorbing performance and greater comfort. Loop wheels give you a smoother ride.They are more comfortable than standard wheels: the carbon springs absorb tiring vibration, as well as bumps and shocks. They're extremely strong and durable.Loop wheel springs are made from a composite material, carefully developed to give optimum compression and lateral stability as well as strength and durability. Specially-designed connectors attach the springs to the hub and rim. The three loops in each wheel work together as a self-correcting system. This spring system between the hub and the rim of the wheel provides suspension that constantly adjusts to uneven terrain – cushioning the rider from bumps and potholes in the road. In effect, the hub floats within the rim, adjusting constantly as shocks from an uneven road hit the rim of the wheel. The spring configuration allows the torque to be transferred smoothly between the hub and the rim.

***Keywords*:** Loop wheel system, hub, rim,specially designed connectors.

INTRODUCTION

A Loopwheel is a wheel with integral suspension, designed for better shock-absorbing performance and greater comfort. Loopwheels give you a smoother ride. They are more comfortable than standard wheels: the carbon springs absorb tiring vibration, as well as bumps and shocks. They're designed for everyday use and are strong and durable.[1] They reduce jolting and vibration, by as much as two thirds compared with a spoke wheel. They made the decision to focus just on wheelchair wheels because the demand for these was really strong, and but it is very small company.[1] A loopwheel for bikes is an awesome ride.

The loop wheels concept is found which has become a very beneficial to the world which reduces the wear and tear of bearing that makes novice after completion its specific life which increases the cost and maintenance of a bicycle. In this case the loop wheels gives a better results and reduces this all the bad impacts created by the normal cycles and gives a one new morning to the innovation.[1-2]

Loop wheel springs are made from a carbon composite material, carefully developed and tested to give optimum compression and lateral stability as well as strength and durability. Specially-designed connectors attach the springs to the hub and rim.

The three loops in each wheel work together as a self-correcting system.[2] This spring system between the hub and the rim of the wheel provides suspension that constantly adjusts to uneven terrain, cushioning the rider from bumps and potholes in the road. In effect, the hub floats within the rim, adjusting constantly as shocks from an uneven road hit the rim of the wheel.

The spring configuration allows the torque to be transferred smoothly between the hub and the rim. The spring rate for wheelchair wheels was specifically chosen. Being carefully developed and tested for this particular application. Every loop wheel within a product category has the same compression rate as another from the same category. We check this to assure constant manufacturing quality.

The invention of the wheel falls into the late Neolithic, and may be seen in conjunction with other technological advances that gave rise to the early Bronze Age. Note that this implies the passage of several wheel-less millennia even after the invention of agriculture and of pottery, during the A ceramic Neolithic (9500–6500 BCE). Early wheels were simple wooden disks with a hole for the axle. rounded pieces of longitudinal boards are required.[4] The spoke wheel was invented more recently, and allowed the construction of lighter and swifter vehicles. In the Harappan civilization of the Indus Valley and North western India, we find toy-cart wheels made of clay with lines which have been interpreted as spokes painted or in relief, and a symbol interpreted as a spoke wheel in the script of the seals, already in the second half of the 3rd millennium BCE. The earliest known examples of wooden spoke wheels are in the context of the Andronovo culture, dating to c. 2000 BCE. Soon after this, horse cultures of the Caucasus region used horse-drawn spoke-wheel war chariots for the greater part of three centuries.The spoke wheel was in continued use without major modification until the 1870s, when wire wheels and pneumatic tires were invented.[3-4]

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.[2] 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.[2]

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A loop spring is a simple type of suspension spring commonly used in vehicles. This type of spring is typically constructed of one or more flat, thin, flexible steel strips that are joined together in order to work as a single unit. The steel strip of a leaf spring are curved into an arc and attached at each end to the underside of a vehicle to help position and support the axle, and also to absorb shock.[4]

Loop springs are usually more able to evenly distribute the weight of a heavy load than ordinary coil-type springs. Although leaf springs have been in use for hundreds of years, they are generally only used for trucks and other heavy-duty vehicles today. Leaf springs are sometimes referred to as semielliptical, cart, or laminated springs.

The center of this arc-shaped spring is usually attached to the axle of the vehicle it supports, while the ends of the spring are attached to the frame itself.[4] In some cases, a leaf spring may be attached to the vehicle frame on one end and other end will be attached to a short swinging arm known as a manufacturer has recently developed a leaf spring that is constructed of a composite material similar to plastic in order to provide a softer type of rear suspension.

In today's world, Bicycles are the most favourite choice when it comes to causes like health, pollution, and environment. Several researches have been done in order to make the ride comfortable. Different types of cycles have been developed for various applications like Commuter Bikes, Mountain Bike, and Racing bike. This paper presents the Loop wheel which is designed such that the suspension system is integrated within wheel for higher shock-absorbing performance and better comfort. Loop wheels offer you a smoother ride. Loop wheel springs are usually made up of a composite material carefully developed to offer optimum compression and lateral stability as well as strength and durability. The three loops in every wheel work along as a self-correcting system. This spring system between the hub and the rim of the wheel provides suspension that continuously adjusts to uneven terrain cushioning the rider from abnormalities in the road wheel. A wheel which is a circular part is meant to rotate on an axle bearing. 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. A wheel greatly reduces friction by facilitating motion by rolling along with the use of axles. For the 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. The loop-wheel suspension concept represents new approach to off-road mobility taking advantage of modern high strength composites. The loop-wheels excellent ride qualities were overshadowed by their very poor durability and high rolling resistance. New design options are presented which promise further improvement in durability, on road and off-road mobility, noise and vibration suspension, lower part count and lower cost for wide range of attractive applications ranging from low speed agricultural trailers to high mobility on/off road motor vehicles.[9]

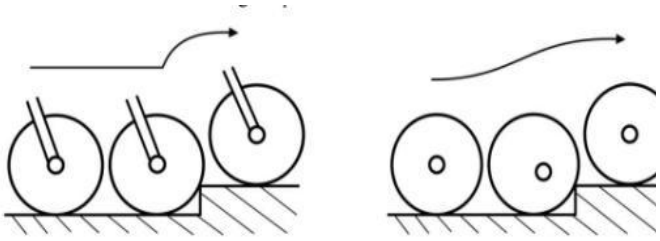


Fig1: Normal wheel DesignFig 2: Modified Wheel

MATERIAL USED

The material used for loop springs is usually an aluminium alloy. The loops are heat treated after the forming process. The heat treatment of aluminium alloy products are greater strength and therefore greater load capacity, greater range of deflection and better fatigue properties. The reinforcement material employed was brass and bronze primarily made up of copper-zinc and copper-tin. The hardener HY951is used in the proportion of 1:10. The choice of hardener is governed by the curing temperature and pot life. The experimentation includes fabrication and testing of different % by volume of aluminium alloy. The composite loop spring is fabricated using best composition of aluminium alloy.

Material	**Young's modulus**	**Poisson's ratio**	**Tensile strength**	**Density**
Aluminum alloy	50-69 GPa	0.32-0.35	310 MPa	2700 kg/m^3
Mild steel	210 MPa	0.303	440 MPa	7850 kg/m^3

RESULTS & DISCUSSION

- **Dimension of loop spring:-**

Parameters	Value
Total Length Of loop Spring [L]	700 mm
Thickness Of Loop Spring [T]	5 mm
Width Of Loop Spring [B]	50 mm
Outer Diameter Of loop [D_1]	210 mm
Inner Diameter Of loop [D_2]	200 mm
Number of graduated loop wheels [n]	3

- **Notations: -**

T - Thickness of each loop.

N - Number of graduated loops.

L - Length of the spring

E – Modulus of elasticity.

F- Force applied at the end of the loop spring.

- **Theoretical Calculations :-**

Bending stress is the normal stress that is induced at a point in a body subjected to loads that cause it to bend. When a load is applied perpendicular to the length of a beam (with two supports on each end), bending moments are induced in the beam.

$$\text{Bending stress,} \quad \sigma b = \frac{\text{mmax}}{\text{z}}$$

Deflection is the degree to which a structural element is displaced under a load.

Strain energy is defined as the internal work done in deforming the body by the action of externally applied forces.

- **LOOP SPRING:**
- **Calculation for total load on each wheel,**

Total mass of rider= 60kg

Total mass of bicycle= 10kg

Total mass of system= 70kg

Total vertical force= 700N

As this force is acting on both the tires for each wheel the value of force=350 N

Now this is the maximum value of force against which we have to design loop wheels.

- **Wheel Specification:**

Rim Diameter = 560 mm

Rim outer width = 30 mm

Rim Circumference = 1760 mm

- **Materials Used:**

Aluminum alloy, Mild Steel.

Ultimate tensile strength = 310 Mpa

Yield strength = 276 Mpa

Elongation = 25 percent

As this force is acting on both the tires for each wheel the value of force=350 N . Now this is the maximum value of force against which we have to design loop wheels. Here we are selecting aluminium material for loop, with 5 mm thickness. So we have to design the system against bending stresses by considering the positive bending.

By using the flexural formula for pure bending,

$$M/I=\sigma/Y=E/R$$

I=Moment of inertia

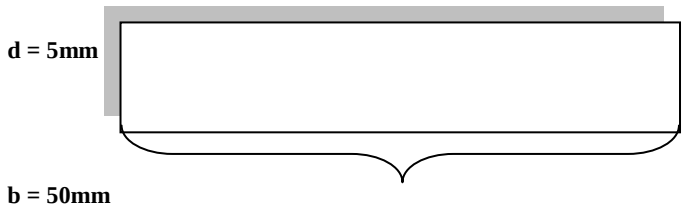
Y=Position of neutral axis

σ=Stress induced

E=Modulus of elasticity

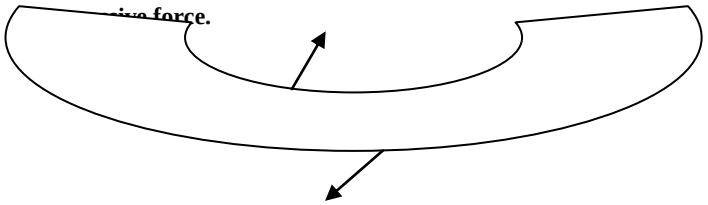
R=Radius of curvature

M=Maximum moment value.



b = 50mm

Fig: Side view of beam.



Tensile force.

Fig: Positive bending.

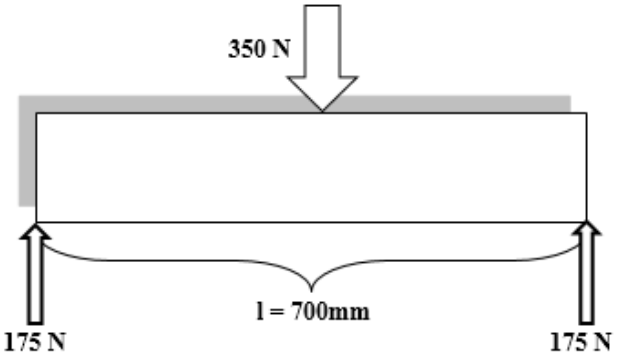


Fig: Front view of beam.

Maximum bending occur at the center. In our case this is the point where outer wheel is connected to the loop.

M = Bending moment at center = W/2 * L/2

M= 175 * 175 = 30.625 N-m.

As we know the cross section value of M.S. material strip, we are using for loop.

b= 50 mm

d=5 mm

Moment of inertia (Ixx) = bd^3/12 = (50)*(5)^3/12 = 520.83 mm^4

Position of neutral axis(Y) = d/2=2.5 mm

From the above diagram the maximum value of moment=30.625 N-m

$$\sigma= (M*Y)/(I)$$

$$=30.625*2.5/520.83$$

$$\sigma=147 \text{ N/mm2}$$

As the Sut of aluminium is lies between 300 to 310 N/mm2 our design is safe.

- **Maximum deflection-**

L=300= major axis of the loop spring.

$$\partial_{max} = FL^3/48EI$$

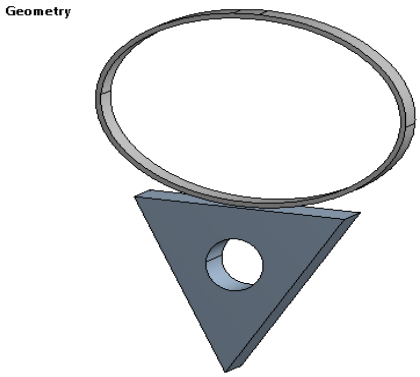
$$=350*(300)^3/48*69*10^3*520.83$$

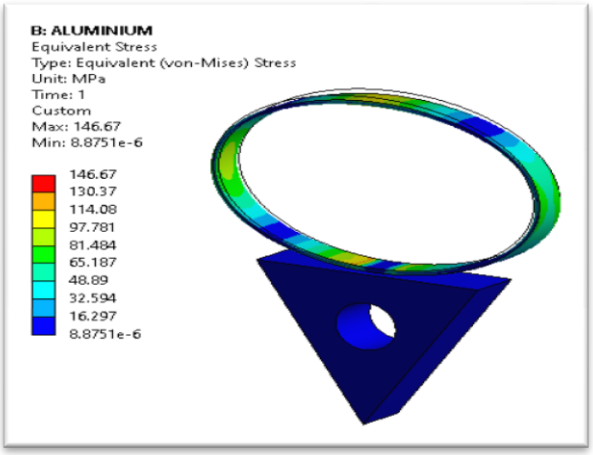
$$\partial_{max} = 5.478 \text{ mm}$$

This is the maximum value of deflection occurs when a person sits on the bicycle.

ANALYSIS RESULTS AND DESIGN

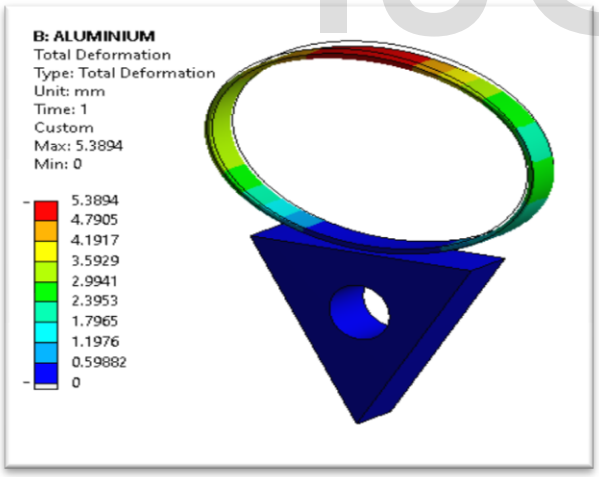
- **Basic Geometry: -**





- **Meshing in ansys :-**

- **Result- Total deformation : -**



- **Equivalent stresses : -**

CONCLUSION

- Deflection of composite leaf spring is less as compared to steel leaf spring with the same loading condition. Weight and cost are also less in composite leaf spring as compared to steel leaf spring with the same parameters.
- Conventional steel leaf spring is also found to be 5.5 times heavier then Jute E Glass/Epoxy resin leaf spring. Composite leaf spring can be used on smooth roads with very high performance expectations.
- 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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