Design, Modelling and Analysis of Loop Wheel Bicycle for Enhancing the Performance

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Abstract - In today's world, Bicycle are the generally much loved excellent once it comes to cause like health, pollution and environment. More than few researches own been finished in peacefulness to present the provoke comfortable. Sundry types of cycles come with been industrial for numerous applications like person along for the ride Bikes, Mountain Bike, and Racing bikes. This make inquiries daily presents the round turn which is planned such that the suspension system is integrated inside wheel for senior shock- absorbing show and surpass comfort. The three loop in every wheel design beside as a self-correcting system. This bounce system between the focal point and the border of the turn provide suspension that ad infinitum adjusts to asymmetrical ground cushioning the specification from abnormalities in the street wheel. The give configuration permit the torque to be transferred smoothly between the centre and the rim.

Key Words: Rim, Loop Wheel, Suspension System, Leaf Spring, Shock, ANSYS 2019 R3 Workbench, Triangular Hub.

1.INTRODUCTION

A Loop wheel is a controls with important suspension, calculated for superior shock-absorbing execution and bigger comfort. Loop wheels go you a smoother ride. They are additional comfortable than typical wheels: the carbon springs absorb laborious vibration, as perfectly as bumps and shocks. They're intended for everyday aid and are effective and durable.

The loop wheels for wheelchairs refrain from relations force over irregular streets, estimated tracks and nettle paths, with a lesser amount of effort, and the carbon springs perform you more potential to grasp up or down kerbs. They decrease jolting and vibration, by as greatly as two thirds compared with a spoked wheel. They finished the conclusion to focus completely on wheelchair wheels as the claim for these was exceedingly strong, and but it is exact miniature company.

Fig. 1 Loop Wheels for Bicycle

The loop wheels model is set up which has suit a exact beneficial to the humankind which reduces T garb and tear of attitude that makes novice after completion it's limited being which increases the loss and maintenance.

This research paper present a examine of a In-Wheel suspension system which is sited inside a bicycle wheel. The In-Wheel suspension system isolates the sprung majority from excitation alike to conventional suspension system. In accepted suspension system the isolation is provided by hara work and complex mechanism, and fir the most part in the vertical direction.

2 . LITERATURE REVIEW

"Mono Composite Leaf Spring for Light Weight Vehicle – Design, End Joint Analysis and Testing" by Gulur Siddaramanna, Shiva Shankar, Sambagam Vijayarangan

Author says, a only piece of paper with patchy thickness and width for trustworthy annoy sectional vicinity of unidirectional tumbler grain durable false (GFRP) with comparable mechanical and geometrical properties to the multi sheet mechanism was designed, made-up (hand-layup technique) and tested. central processing unit algorithm by means of C-language has been old for the object of regular cross-section sheet spring. The domino effect showed that an leap width

decreases hyperbolically and thickness increases linearly from the movement eyes towards the axis seat. The limited ingredient fallout by ANSYS software presentation stresses and deflections were verified with reasoned and experimental results. Compared to the steel spring, the composite bounce has stresses that are a good deal lower, the inborn frequency is privileged and the jump power is just about 85 % subordinate with bonded stop linkage and with entire discrimination unit.

"Design and Analysis of Composite Leaf Spring for Light Vehicles" by Pankaj Saini, Ashish Goel, Dushyant Kumar

Author says that, the auto engineering has vast draw your attention for substitution of steel folio helix with that of composite folio spring, since the composite equipment has far above the ground intensity to significance ratio, sunny deterioration resistance. The information select was flute fibre shatterproof polymer (E-glass/epoxy), carbon epoxy and graphite epoxy is old against conventional steel. The aim parameters were elected and analyzed with the objective of minimizing authority of the composite sheet leap as compared to the steel folio spring. From the static psychoanalysis domino effect it is set up that here is a limit disarticulation of 10.16mm in the steel sheet jump and the corresponding displacements in Eglass / epoxy, graphite/epoxy, and carbon/epoxy are 15.mm, 15.75mm and 16.21mm respectively. amid the three composite folio springs, simply graphite/epoxy composite folio bound has senior stresses than the steel piece of paper spring.E-glass/epoxy composite folio bounce canister be optional for replacing the steel folio leap from stress and firmness statement of view.

"Design and Analysis of a Leaf Spring for automobile suspension system- A Review" by Baviskar A. C., Bhamre V. G., Sarode S. S.

The author says that, Composite equipment get extra expandable strain energy cargo space part and climax muscle to importance ratio as compared with folks of steel. Therefore, it is concluded that composite sheet launch yourself is an actual proxy for the untaken steel sheet bounce in automobile. E-glass epoxy is advance than by Mildsteel as nevertheless stresses are modest speck privileged than mild steel, E-glass epoxy is having accomplished yield potency value. The significance of the piece of paper pounce is low-price greatly about 85 % by replacing steel folio leap with composite sheet helix.

"Design and Analysis of Leaf Spring with Composite materials" by Mr. Tharigonda Niranjan Babu, Mr P. Bhaskar, Mr. S. Moulali

Author says that, the beginning of composite equipment has complete it probable to moderate the influence of the piece of paper leap without any decrease in oppress hauling amount and stiffness. sheet helix is modelled in CATIA V5R20 software and it is imported in ANSYS 12.0. The conventional composite folio springs were analyzed under analogous state of affairs by means of ANSYS software and the consequences are presented. Deflection of composite piece of paper bound is take away as compared to steel folio jump with the equal loading condition.

"Urgent Operational Requirement: Build your own loop wheel"

The Loop wheels are a new conception steering wheel for a bicycle. The spokes of a conventional sweep possess been replaced with carbon fibre loops which not no more than fix the external rims to the centre hub, they additionally afford suspension. The effect is utmost comfort over bumps and a lesser amount of throb from the road. Replacing the spoked wheels with disk wheels provides extensive suspension in a cycle which hasn't got space for a conventional suspension system, but apiece disk circle weighs lone about 300g new than its spoked equivalent. disparate suspension forks, which individual control in one plane, Loop-wheels offer divergent suspension. That is, they operate in every direction. subsequently they retort to a coerce hurt headon in the identical fashion as they accomplish to a strength from above or below. By means of loop-wheel bicycle proviso gets comfortable drive as at a tangent suspension. Pedaling is to a great extent smoother and not as jerky, as the springs emit energy additional evenly. This makes for a exceedingly comfortable, cool ride.

"Loop wheels: because sometimes it's good to reinvent the wheel."

Loop wheels are a new print of bicycle sweep that boast been planned to render cycling supplementary comfortable. Loop wheels item a skip system between the focal point and the circumference of the circle which provides suspension cushioning the criterion from bumps and potholes in the road. The helix configuration allows for the torque to be transferred smoothly between the core and the rim. face and rear Loop-wheels own numerous helix rates. A face and rear loop-wheel preserve be second-hand laid back as a set, or you bottle utilize a specific loop-wheel alongside a conventional spoked wheel. Loop-wheels make available suspension on a motorcycle which has none, or canister been suite in adjunct to suspension forks to make happen a smoother, other comfortable ride.

2.1 PROBLEM STATEMENT

The natural round creates the blast after its energy gets reduces and during solid jerk or in addition at the same time as free to tracking it increases the percentage of possibility of being paid hurt to border which ropes the wheels though they are in rotating motion. During off street position the conventional rotation generates a substantial cogency that creates the ago ache of creature being.

2.3 RESEARCH OBJECTIVE

The loop wheel belief has been commence after making an allowance for every one of this harms facing during our day by day life. By observing the sheet suspension in trucks etc. the new suggestion

fashioned of ball circle which gives most strong suit during off thoroughfare vehicle as admiringly as on path vehicle. The loop wheel project know how to underestimate the shocks that has been fashioned during riding.

3. METHODOLOGY

Phase 1: Data Collection

Data collection phase involves the collection of reference material for project concept.

Phase 2: System Design

The system design comprises of development of the mechanism so that the given concept can perform the desired operation.

Phase 3: Mechanical Design

The parts in the part list will be designed for stress and strain under the given system of forces, and appropriate dimensions will be derived.

Phase 4: Drawing

Production drawings of the parts are prepared using AutoCAD, with appropriate dimensional and geometric tolerances. Raw material sizes for parts are also determined.

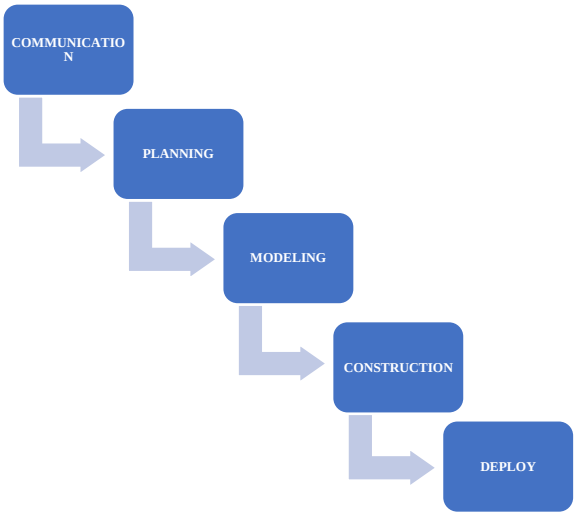


Fig. 2 Waterfall Model

We have decided to complete the project in simple waterfall model.

Phase 5: Material Procurement And Process Planning

Material is procured as per raw material specification and part quantity. Part process planning is done to decide the process of manufacture and appropriate machine for the same.

Phase 6: Manufacturing

Parts are machined as per the requirement and standard parts and electronic components are to be purchased.

Phase 7: Assembly Test And Trial

Assembly of device is done as per assembly drawing and test and trial is conducted on device for evaluating performance.

Phase 8: Reporting And Representation

Report preparation of the activities carried out during the above phases is done.

4. CATIA MODEL

his time for CAD displaying explanation utilizes a PTC Creo Parametric CAD Software. It is an intense, corresponding troupe of entry outline programming. The conduct in which Creo machinery is that it is comprised of character applications, counting Creo Parametric, Creo Simulate, Creo Direct, Creo Layout, Creo Options Modeler all Creo app serves a distinctive point in the produce advancement process. This channel that Creo takes you through every stage, counting conception goal work, drawing and analysis. at this juncture are a little unlike select shots of unique parts industrial in CAD Software for modeling rationale which is coming aid for analysis.

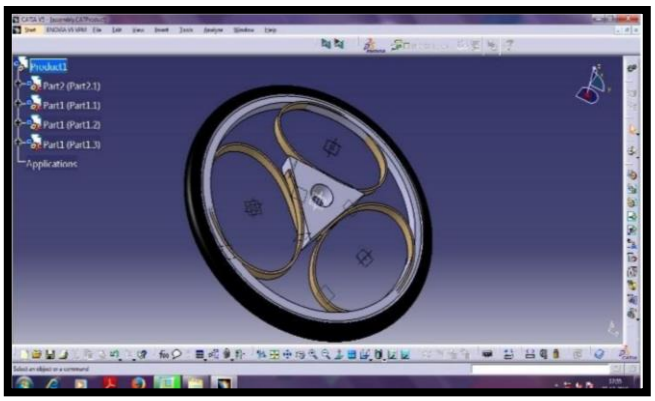


Fig. 3 CATIA Model of Loop Wheel Model

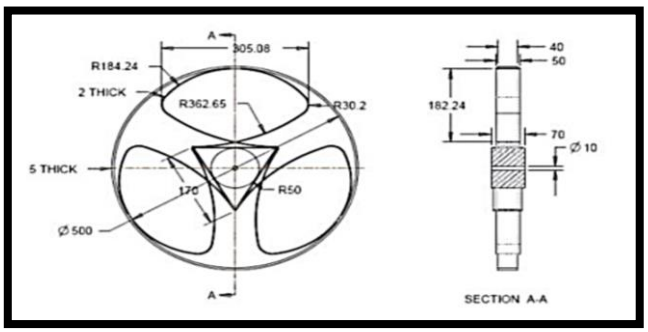


Fig. 4 CAD Drawing Of Loop Wheel

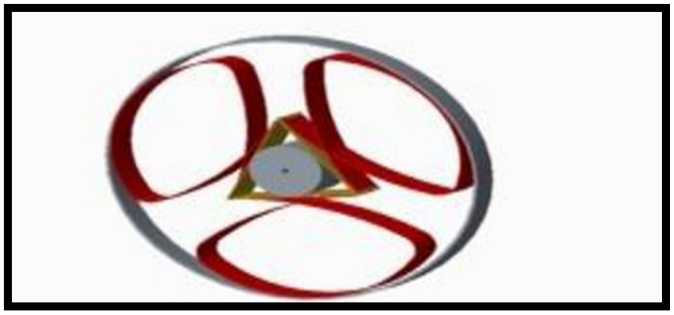


Fig. 5 PTC Cero CAD Model of Loop Wheel

5. EXPERIMENTAL WORK

5.1 Design

Dimension of cross section of the leaf is to be determined. The width of the leaf material was kept as 25.4 mm as it cannot be more than the width of the wheel.

Considering front impact case, using impulse momentum theorem,

$F \times t = m \times v$

Given data:

Time of impact, t = 0.5 sec

Mass of cycle including rider, m = 100 kg Max.

Velocity, v = 30 kmph = 30 × 1000/3600= 8.3 m/s

For 100 kg, F = m × g = 100 × 9.81 = 981 N

For determining the thickness of the Leaf,

let us consider it as a cantilevered

Major Axis of Loop Spring (L) = 300 mm (12 inch)

Minor Axis of Loop Spring (h) = 195 mm (7.8 inch)

Width of spring (b) = 25. 4 mm (1inch)

E = 200 Mpa = $200 \times 10^3 = 2 \times 10^5$

5.2 For C10 Material

Tensile strength = 365 N/mm²

σ max = 36/51= 365 N/mm²

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

$365 = 3 \times 981 \times \frac{300}{2} \times 1 \times 25.4 \times t^2$

t = 6.90 mm For 100 kg weight

Given data:

Take t = 6 mm thickness of the leaf is required

m = 100 kg

$v = 30kmph = 30 \times \frac{1000}{3600} = 8.3$ m/s

F = m × g = 100 × 9.81 = 981 N

Thickness of spring t = 6 mm

1. Calculation of maximum principal stress for loop wheel

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

$= 3 \times 372.78 \times 300/2 \times 1 \times 25.4 \times 6^2$
$= 183.45$ N/mm² < 365 N/mm²
Hence design is safe

2. Calculation of maximum deflection in loop Wheel

$\Delta max = \frac{3FL^3}{8nbt^3E}$

$= 3 \times 372.78 \times 300^3/8 \times 1 \times 25.4 \times 6^3 \times 2 \times 10^5$

= 3.44 mm.

Above computations were finished considering half segment of spring consequently add up to abandonment would be, max = 3.44 × 2 = 6.88 mm. Henceforth plan safe.

5.3 For C20 Material

Tensile strength = 560 N/mm²

σ max = 560/1 = 560 N/mm²

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

$560 = 3 \times 981 \times \frac{300}{2} \times 1 \times 25.4 \times t^2$

t = 5.57 mm For 100 kg weight

Given data:

Take t = 5 mm thickness of the leaf is required

m = 100 kg

$v = 30kmph = 30 \times \frac{1000}{3600} = 8.3$ m/s

F = m × g = 100 × 9.81 = 981 N

Thickness of spring t = 5 mm

3. Calculation of maximum principal stress for loop wheel

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

$= 3 \times 372.78 \times 300/2 \times 1 \times 25.4 \times 5^2$
$= 264.17\ N/mm^2 < 560\ N/mm^2$
Hence design is safe

4. Calculation of maximum deflection in loop Wheel

$\Delta max = \frac{3FL^3}{8nbt^3E}$

$= 3 \times 372.78 \times 300^3/8 \times 1 \times 25.4 \times 5^3 \times 2 \times 10^5$

$= 5.94$ mm.

Above computations were finished considering half segment of spring consequently add up to abandonment would be, max = 5.94 × 2 = 11.88 mm. Henceforth plan safe.

5.4 For C30 Material

Tensile strength = 765 N/mm^2

σ max = 765/1 = 765 N/mm^2

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

$765 = 3 \times 981 \times \frac{300}{2} \times 1 \times 25.4 \times t^2$

t = 4.76 mm For 100 kg weight

Given data:

Take t = 4 mm thickness of the leaf is required

m = 100 kg

$v = 30kmph = 30 \times \frac{1000}{3600} = 8.3$ m/s

$F = m \times g = 100 \times 9.81 = 981$ N

Thickness of spring t = 4 mm

5. Calculation of maximum principal stress for loop wheel

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

$= 3 \times 372.78 \times 300/2 \times 1 \times 25.4 \times 4^2$
$= 412.77\ N/mm^2 < 765\ N/mm^2$
Hence design is safe

6. Calculation of maximum deflection in loop wheel

$\Delta max = \frac{3FL^3}{8nbt^3E}$

$= 3 \times 372.78 \times 300^3/8 \times 1 \times 25.4 \times 4^3 \times 2 \times 10^5$

$= 11.60$ mm.

Above computations were finished considering half segment of spring consequently add up to abandonment would be, max = 11.60 × 2 = 23.22 mm. Henceforth plan safe.

Material	Result
C10	6.82
C20	11.8
C30	22.84

Table 1. Calculated Deflection in all Materials

Material	Result
C10	7.81
C20	14.65
C30	24.66

Table 2. Experimental Deflection in all Materials

6. RESULT AND DISCUSSION

The safety of the design. Using impulse momentum principle, force was calculated when the cycle hits a rigid wall with a velocity of 30 kmph. The resultant Equivalent Stress (MPa) and Total Deformation as shown in table. The force obtained was 981 N. i.e. 100 Kg., Table1 Result of Deformation and Stress developed

Material	Maximum	Minimum	Average deflection
C10	6.82	0	3.41
C20	12.162	6.635	9.39
C30	25.99	15.870	20.93

Table 3. ANSYS values in all materials

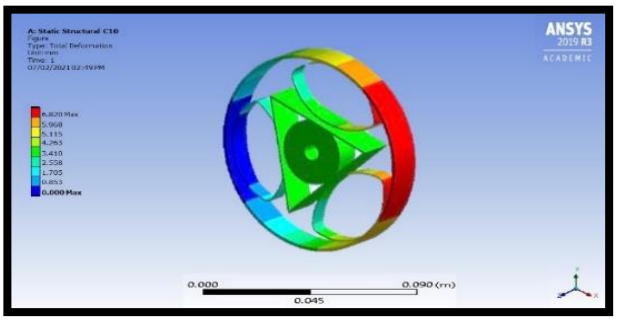


Fig.5 ANSYS result of deformation in C10 material for Loop Wheel

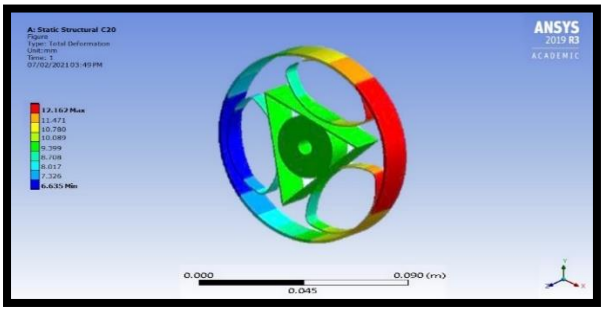


Fig. 6 ANSYS result of deformation in C20 material for Loop Wheel

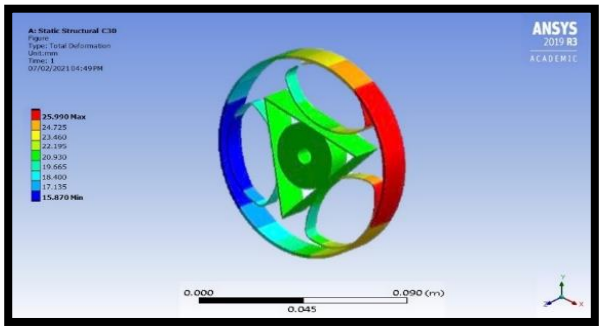
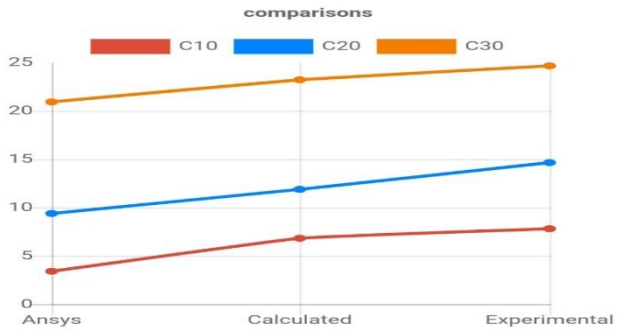


Fig. 7 ANSYS result of deformation in C30 material for Loop Wheel

Graphical comparisons



7. CONCLUSIONS

Bicycle with loop wheel suspension system provides smoother ride, sky-scraping shock captivation capacity, avoids the basic of other suspension system. Additionally this loop wheel container stumble on their application in steering wheel chair, mountain bikes as of their scope to fiddle with to not level terrain, cushioning the disclaimer from abnormalities in the road. Examination on twist has been finished which shows that the calculated and the ethics obtained by means of ANSYS 2019 R3 workbench are in accordance with all other which advocate that the outline is safe. In loop design, the stresses urban in round bounce under the safe hands bounds of data stress check and so the outline is customary but the draft of spokes in conventional circle enable polite stress allocation than loop spring.

8. ACKNOWLEDGEMENT

I express true sense of gratitude towards my project guide **Prof. Tushar D. Garse** for his invaluable co-operation and guidance that he gave me throughout the project preparation. I am also thankful to my project co-guide **Prof. Kundan K. Chaudhari** for his valuable guidance in M-TECH course (Machine Design Engg).

9. FUTURE SCOPE

Going back to the loop wheels problem of how best to make the springs and thinking that carbon composites were going to be the answer, I took inspiration from my immediate environment. One idea that carbon composite archery bows probably went through similar kinds of stresses as the springs in wheels. So let's try out for other designs like archery bow with carbon composites, no matter it is costly than steel but it is better effective than steel because of its material properties and simple of manufacture. A spring framework between the center point and the edge of the wheel pads the rider from knocks and potholes in the street. Since the suspension framework is situated inside.

10. REFERENCES

10.1 JOURNAL PAPERS

[1] Yung-Shung Liua, Tswn-SyauTsayb, Chao Chenc, Hung-ChuanPanc ("Simulation of a riding a full suspension bicycle for analyzing comfort and pedalling force") accepted 29 May 2013.

[2] Nicola Petrone, Federico Giuliano-("Methods for evaluating the radial structural behavior of racing bicycle wheel") University of Padova, Italy; accepted 16 May 2011.

[3] Jobst Brandt, The Bicycle Wheel Third Edition.

[4] Pankaj Saini, Ashish Goel, 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.

[5] Covilla, Steven Begga, Eddy Eltona, Mark Milinea, Richard Morrisa, Tim Karza, " Parametric finite element analysis of bicycle frame geometries".

[6] Song Yin, Yuehong Yin-(" Study on virtual force sensing and force display device for the interactive bicycle simulator"); accepted 10 June 2007.

[7] Baviskar A. C. Bhare 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, Vol. 3, Issue 6, June 2013, PP 406 – 410.

10.2 BOOKS

[8] A Text Book of Mechanical System Design, Farzdak Haidari, Third Edition, Chapter 2, Page No. 149 – 241.

[9] Strength of Material S. Ramamurutham, R. Narayan, Dhanpat Rai Publication Company, Page No. 116 – 118.

[10] Mechanics of Material l Third Edition, E. J. Hearn, University of Warwick, United Kingdom, Chapter 1.

[11] Shigley, Joseph Edward, "Theory of Machine and Mechanism" , Tata McGraw Hill, New York, 2003.

10.3 ADVERTISING POSTERS

[12] Info@Loop-wheels.com, A advertising poster, " Loop-wheels : because sometimes good to reinvent the wheel".

[13] Info@Loop-wheels.com, A advertising poster, " Loop-wheels".

[14] An advertising poster, "Urgent Operational Requirement : Build your own loop wheel".

10.4 INTERNET

[15] http//en.wikipedia.org/wiki/Rolling_resistance

[16] http//en.wikipedia.org/wiki/Drag_coefficient

[17] http//en.wikipedia.org/wiki/Bicycle _frame#Roadster/utility_bicycles

11. BIOGRAPHIES

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