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Design and Fabrication of Steering System for Trike

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Abstract- This work consists of designing, drafting, analysis, prototyping, general iterations related to linkages. The steering system of a vehicle consists of two subsystems; A steering rod that matches the angles of rotation of all steering wheels, and an actuating subsystem that connects the driver's steering wheel to a movable element of the steering rod. In vehicles with rigid steering axles, the most commonly used tie rod is a simple mechanism; we will design this mechanism as an anti-Ackermann linkage mechanism involving 6 joints. An Anti-Ackermann steering linkages for short wheelbase, three wheel vehicles base been developed. Link coordinate steering angle of each wheel, coordinate steering angle of each wheel in the range of 180 degrees with minimum misalignment between wheels. Control of steering angles is accomplished using a single linear actuator. Control complexity is lower compared to four wheel systems using individually controlled steering actuators for each wheel. For the electric wheelchair base, a prototype linkage was designed and tested to achieve a minimum turning radius while maintaining maximum stability.

Keywords- Steering, Angle, Wheel, Design, Linkages..

I. INTRODUCTION

Steering system is the group of parts, linkages, etc. which allow a ship, boat type design or vehicle like car, motorcycle, bicycle etc. to allow the desired need. The basic aim of steering is to ensure that the wheels are pointing in the required directions. This can be achieved by a number of linkages, rods, pivots or gears.

Commonly used steering gears for four-wheeled vehicles are four-linked arms, often referred to as Ackermann-type steering gears. The input motion from the driver at the steering wheel is transmitted via a steering box and the steering control linkage to one of the steering knuckles and then transmitted to the second through Ackermann steering linkage.

The basic kinematic requirement for a vehicle's steering linkage is to provide the steering wheels with a coherent axle so that their axes intersect at a point on the rear axle.

The goal of Steering Synthesis is to reduce the gap between the steering centers over the entire steering angle input range, while fitting within a reasonable gap. To obtain the target, several conflicting requirements should be simultaneously considered. The aim of this work is to design steering for tricycle which is efficient, light weight, which can be install easily and maintenance is also easy. Whose Spare parts can be available and manufacture easily.

II. LITERATURE REVIEW

There are some researches done over this topic are discussed here:

P. Deepak et. al. [1] publish a research paper on the tittle analysis of Three Wheeled Dual Steering Vehicle in which there main area of interest is design the steering on three wheelers but the steering choose is dual steering on studying this research paper we came to know what a three wheeler steering is all about although we are not looking for dual steering system so we go to another research paper.

Rahman, M. T. A. et. al. [2] There is an article on Anti-Ackermann steering which states that Anti-Ackermann was designed primarily for race cars to provide a handling advantage in tight corners race courses where increased outer wheel steering angles are needed .In 1818, Rudolf Ackerman patented a design of Georg Lankensperger that provided a steering system for carriages that eliminated the angle scrub and subsequent wear of the wheels on the front axle.

After selecting anti Ackerman geometry for our concern we looked for another research papers.

Dwaipayan Roy Chowdhury and aditya mitra [3] explains different configuration of three wheelers mainly tadpole configuration which we used in our project there are some design consideration and aspect which is suitable for our purpose.

Dr. V.K. Saini [4] gives tandem configuration with Ackerman geometry as we fixed tandem configuration earlier now its time to check the capabilities by using the researches which is done earlier before on the following topic with the different approaches. As same we take another survey.

Jing-Shan Zhao et. al. [5]researched linkage steering application on Ackerman geometry as we are using linkage mechanism this information is useful to us for the area of study.

V. Babu et. al. [6] studied the different steering configuration study and checked based upon the suitable application but we found anti Ackerman most suitable and then we applied. It is very essential for ergonomics factor of safety for a human which is going to ride the vehicle the its first priority to not harm the human for which we are working so we done a survey for this factors which affects mostly.

Zeshan Ahmad [7] discussed about the various economic factors to be considered for steering mechanisms.

On the basis of this all survey done for our purpose of making a steering for a hybrid tricycle is complete at the study and research par is completed now we are confirmed with the idea of our steering we analyse different type of configuration and steering system and then finally we came us with tadpole configuration with Anti Ackerman geometry which will provide us a the desired result with suitable factor of safety with taking ergonomics into consideration.

II. METHODOLOGY

1. Idea:

While doing it we went through following methods:

- Preparing rough concepts of mechanisms that can achieve our requirements.
- Selection of best rough concept
- Preparing CAD models of selected concept & checking for its working animation.
- Finding the reasons constraining the design to work.
- Finding the solutions to those problems.
- Making changes in design based on the solutions made for problems.
- Checking for working animation.
- Improving the design for best working.
- Manufacturing & buying of parts required for implementation of our design.
- Assembly of all parts & components.
- Dynamic tests on the required assembly.
- From beginning to final, we made total five designs. Among them we selected best suitable design.

2. Design considerations:

The function of steering system is to steer the front wheels in response to driver command inputs in order to provide overall directional control of vehicle.

Design steps involved:

- Determination of vehicle requirements
- Geometry Configuration
- Validation of Geometry
- Design of the mechanism.

3. Design Calculations:

For the betterment of Steering System, this year we are using over seat steering with single drag link has been adopted.

4. Specifications:

Table 1. Design Specifications.

S.No.	Parameter	Specification
1	Geometry	Anti-Ackerman Geometry
2	Inner Angle	43^0

Table 2. Formula Used.

S.NO.	PARAMETER	FORMULA
1	Outer Angle	$\theta_{OUT} = Tan^{-1}\{L/(T/2+R)\}$
2	Lock to Lock turns	θ_{IN} • 2 * steering ratio/360^0
3	Turning radius	$Cot\theta - Cot\Phi = C/B$
4	Ackerman angle	$TAN^{-1}(L/2B)$
5	Steering gradient	K= WF /CF – WR /CR
6	Critical speed	V=√ g.r

5. Calculations:

- Inner angle (θ) = 43^0
- Outer angle (ϕ) = 26.45^0
- Steering Ratio = Turn of steering/Turn of tire
  = 0.6: 1
- Steering effort = 7 N
- Lock to Lock Turn = θ_{IN} *2*steering ratio/360
  = 0.20
  Where:- Θ_{IN} = Inner angle
- Critical Speed: V= √ g. r
  = 26.20 kmph
  Where:- V = Critical Speed
  R = Turning Radius
  L = Wheel Base
- Slip Angle: $\alpha = F_y / C_\alpha$
  Front = 3.3^0
  Rear = 2.9^0
- Understeer Gradient (K):
  K = (Wf /g*Caf)-(Wr/g*Car)4
  K= 0.428 deg/gm

Where:-

K = Understeer Gradient

W_f = Weight on front axle

W_r = Weight on rear axle

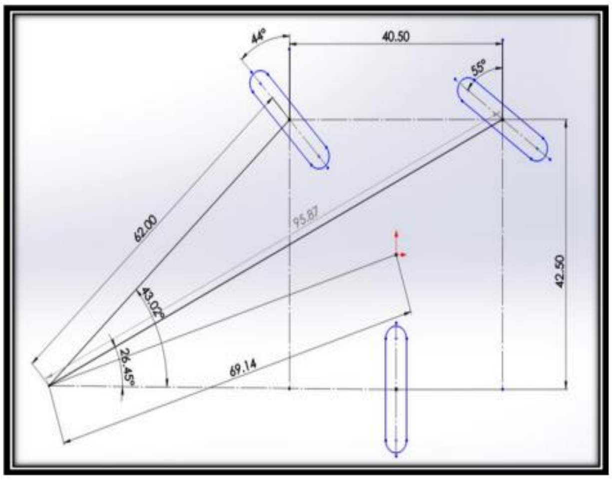

Fig 1. Angle Diagram.

III. TESTING / ANALYSIS

1. Analysis/ Testing of prototype:

Now, for our hybrid steering system the components we have selected are not only fulfill our steering requirements, but also these are efficient and updated in the following ways:- 1. Light in weight. 2. Easy to fabricate. 3. Cheaper than market components. 4. Good strength to weight ratio. 5. Raw materials for fabrication are easily available.

2. Stub Axle Analysis:

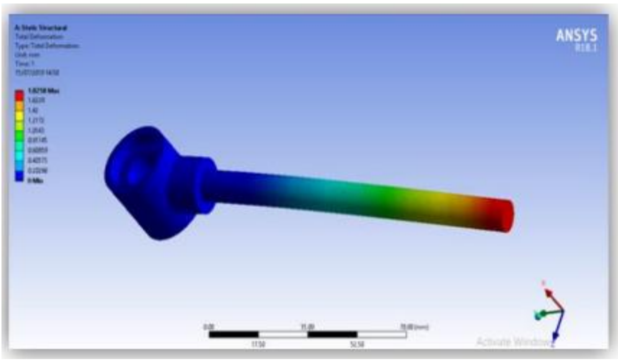

Fig 2. Maximum Stress of Excel.

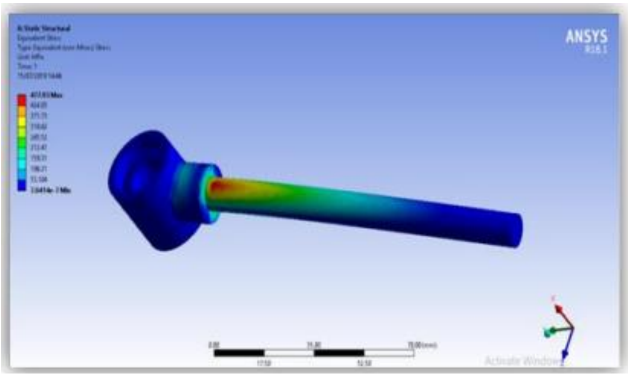

Fig 3. Maximum Strains on Excel.

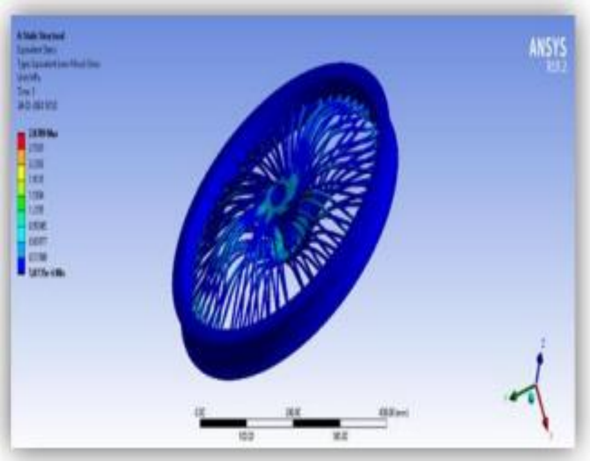

Fig 4. Maximum Strains on Wheel (98).

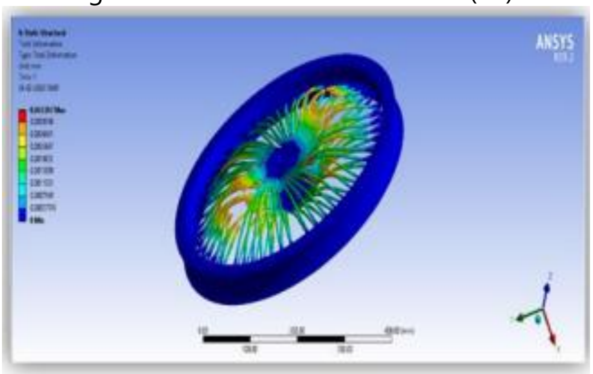

Fig 5. Total Deformation on Wheel.

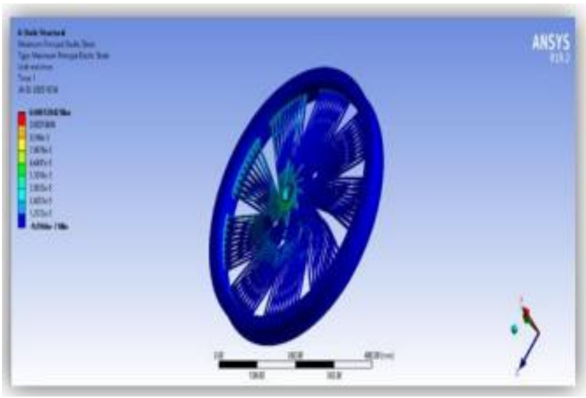

Fig 6. Maximum Strain on Wheel (162).

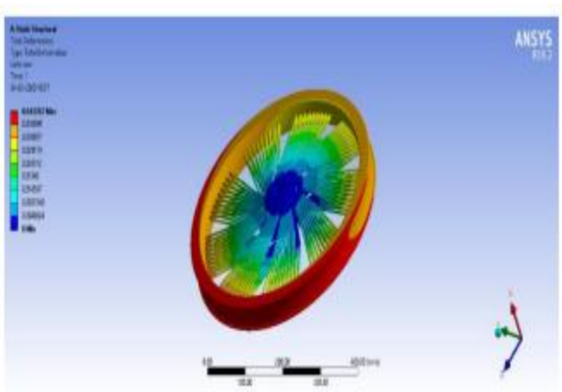

Fig 7. Total Deformation on Wheel (162).

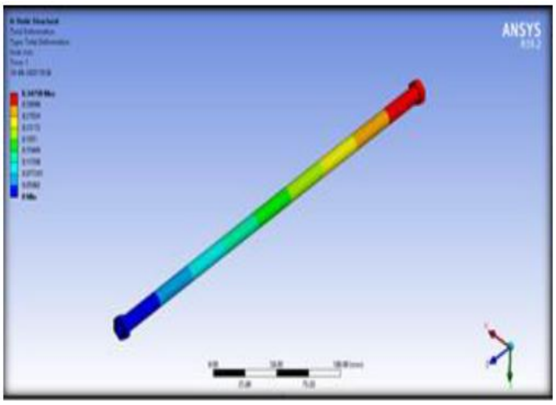

Fig 8. Total Deformation of Tie Rod.

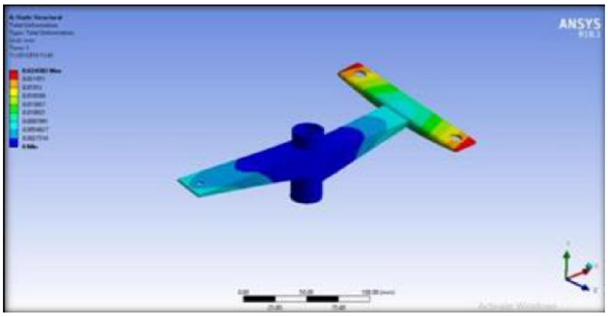

Fig 9. Total Deformation of bell crank.

IV. RESULT AND DISCUSSION

After reviewing the steering system or mechanism that could be employed on personal transporter, the author shall then identify the best steering system to base our design. Design criteria and specifications have to be established before decision could be made and they are as the following:

Table 3. Results.

Criteria	Description
Low cost	Contributes to the overall low cost of the final design
Simple design	Technologies available in developing countries
Easy to maintain	Replacement components available in developing countries
High effectiveness	Provides good turning and stability to the vehicle
Small in size	Take up little space to ensure compact overall design

V. CONCLUSION

We developed or Design and fabrication of steering system of a hybrid tricycle for 2F1R (Tadpole) configuration. Then analyzed it with Ansys software. The specified target which provides more turning and reduce the high speed shimmy and topple.

We have successfully achieved turning of vehicle up to 35 degrees along with reasonably good performance of tricycle on road. The vehicle cornering ability is well tested & gave response as we considered. Our steering system has been successfully implemented in tricycle & is now able to be implemented in different future mobility sources. The chosen design was safest and most reliable vehicle system for any long terrain. All the parameters like safety, cost, performance, durability and material were also taken in consideration on the same time. By changing the steering parameters, the dynamic behavior of the tricycle is changed in favor of the driver. For the future we can go through different variants of steering system in tricycle for example-

- Racing cars
- Carts for sports ground
- Vintage bikes
- General purpose

This steering system would free up space in the power-train compartment by eliminating the steering shaft. One of the most exciting things about our steering system for vehicles is that you can fine-tune vehicle handling without changing in the vehicle's mechanical components.

VI. FUTURE SCOPE

An innovative feature of this steering system design is its ability to drive the front wheels using a single drag link actuator. Its successful implementation will allow for the development of a better steering with a power base with maximum Maneuverability, uncompromised static stability, front and rear wheel tracking, and optimum obstacle climbing capability. The advanced system of our steering system will work electronically with the help of Microprocessors. The system will utilized an on-board computer to control and direct the turning left and right of the rear wheels.

Rather than can communications that we used today, we need something like flex ray to allow high speed communications between like components. So there is a bandwidth issue. And, of course, higher power requirements. Today with electric power steering the driver inputs some torque and we multiply it. With steer by wire, 100% of the effort to steer by wire the vehicle has to come from the electric motor.

REFERENCES

[1] Deepak, P., Reddy, S. V., Ramya, N., Goud, M. B., & Shekar, K. C. (2014). Design and analysis of three wheeled dual steering vehicle. International Journal of Engineering & Technology (IJERT).

[2] Rahman, M. T. A., Rahman, A., & Halim, S. S. (2021, July). Steering system improvement for formula SAE car using Ackermann principle. In AIP Conference Proceedings (Vol. 2347, No.1, p.020081). AIP Publishing LLC.

[3] Dwaipayan Roy Chowdhury and Aditya Mitra", 2019, January, "A Recumbent Trike Design with Maximum Performance and Vehicle Dynamics Analysis", International Advanced Research Journal in Science, Engineering and Technology. Vol. 6, Issue 1.

[4] Saini, V. K., Sunil, K. A., Shakya, K., & Mishra, H. (2017). Design methodology of steering system for all terrain vehicles. International Research Journal of Engineering and Technology, 4(5), 460.

[5] Zhao, J. S., Liu, X., Feng, Z. J., & Dai, J. S. (2013). Design of an Ackermann-type steering mechanism. Proceedings of the Institution of Mechanical Engineers, Part C: Journal of Mechanical Engineering Science, 227(11), 2549-2562.

[6] Chitti Babu, V., Govinda Rao, P., Santa Rao, K., & Murali Krishna, B. (2020). Design of accurate steering gear mechanism. Mechanics and Mechanical Engineering, 22(1), 93-104.

[7] Ahmad, Z., Abhinandan, A., & Sen, R. (2017). Determination of Ergonomics for Formula Student vehicle. International, Journal of Engineering Research and Technology, 6(3), 404-407.