International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 05, May-2016

Formulation of a Standardized Procedure for Designing the Steering System of Small Vehicles Like Go-Karts

Pushkar Wadagbalkar
Mechanical Engineering Department
PES Modern College of Engineering
Pune, India

Chirag Somani
Mechanical Engineering Department
PES Modern College of Engineering
Pune, India

***Abstract*-The documentation includes a description of the design processes adopted for the various parts of the steering system. This begins with the actual design of Ackermann Geometry, steering components and their integration together in SOLIDWORKS, followed by the technical specifications of the final design. The designed steering system was used in a Go-Kart for a student level racing event.**

Keywords-Ackermann, Steering, Geometry, Go-Kart, CAD, Tie-rod, Stub.

I. INTRODUCTION

Steering is the collection of components, linkages, etc. which allow a vehicle to follow the desired course. The primary purpose of the steering system is to allow the driver to guide the vehicle. The steering system is to achieve angular motion of the front wheels to negotiate a turn. This is done through linkage and steering gear which convert the rotary motion of the steering wheel into angular motion of the front road wheels.

Secondary functions of the steering system are:

• To provide directional stability of the vehicle when going straight ahead.

• To provide perfect steering condition, perfect rolling motion of the road wheels at all time.

• To facilitate straight ahead recovery after completing a turn. To minimize tire wear.

Many modern cars use rack and pinion steering mechanisms, where the steering wheel turns the pinion gear; the pinion moves the rack, which is a linear gear that meshes with the pinion, converting circular motion into linear. Older designs often use the recirculating ball mechanism, which is still found on trucks and utility vehicles. The recirculating ball mechanism has the advantage of a much greater mechanical advantage, so that it was found on larger, heavier vehicles while the rack and pinion was originally limited to smaller and lighter ones. To achieve the correct steering, two types of mechanisms are used. They are the Davis & Ackermann mechanism. Ackermann steering geometry is a geometric arrangement of linkages in the steering of a car or other vehicle designed to solve the problem of wheels on the inside and outside of a turn needing to trace out circles of different radius. A simple approximation to perfect Ackermann steering geometry may be generated by moving the steering pivot points inward so as to lie on a line drawn between the steering kingpins and the center of the rear axle. The steering pivot points are joined by a rigid bar called the tie rod which can also be part of the steering mechanism, in the form of a rack and pinion for instance. With perfect Ackermann, at any angle of steering, the center point of all of the circles traced by all wheels will lie at a common point. Note that this may be difficult to arrange in practice with simple linkages, and designers are advised to draw or analyze their steering systems over the full range of steering angles.

Front wheel alignment (also known as front-end geometry) is the position of the front wheels relative to each other and to the vehicle. Correct alignment must be maintained to provide safe, accurate steering, vehicle stability and minimum tire wear. The factors that determine wheel alignment are interdependent. Therefore, when one of the factors is adjusted, the others must be adjusted to compensate.

A. Four bar Ackermann mechanism:

- A four bar Ackerman is basically based on the four bar linkage. In a four bar linkage there are 4 links or bars which are connected in loops by 4 joints. Generally, the joints are configured so that the links move in parallel planes. The Ackerman mechanism uses four bar linkage.
- The input motion from the driver and the steering wheel is transmitted via a steering tie rods and the steering control linkage to one of the steering knuckles and then transmitted to the other one through the Ackerman steering linkage.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 05, May-2016

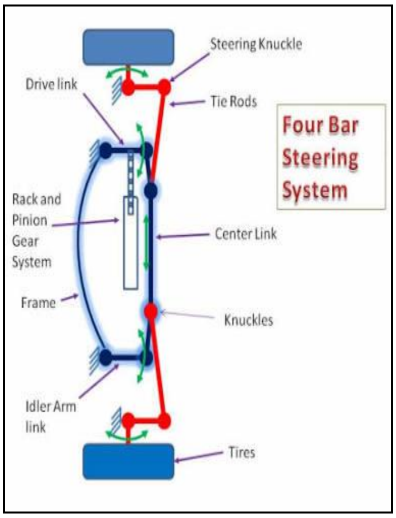

Fig.1 Four bar steering system

B. Ackermann Principle as Applied to Steering.

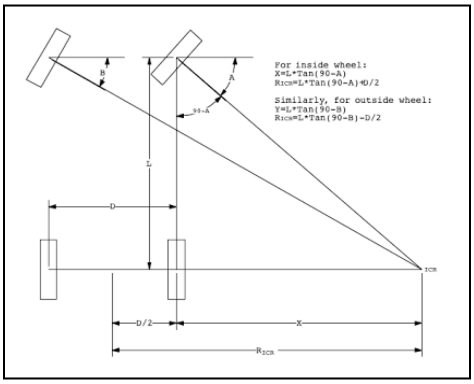

Fig.2. Ackermann Geometry

To achieve true rolling for a four wheeled vehicle moving on a curve track the lines drawn through each of the four wheel axes must intersect at the instantaneous center. The actual position of the instantaneous center constantly changes due to the alteration of the front wheel angular positions to correct the steered vehicles path. Since both rear wheels are fixed on the same axes but the front wheel axles are independent of each other the instantaneous center lies along an imaginary extended line drawn through the axis of the rear axle.

The Ackermann Principle is based on the two front steered wheels being pivoted at the ends of an axle-beam. The main advantage of Ackermann Principle is that during cornering the wheel slippage is minimum and hence gives a better traction which is required in racing.

C. Steering Ratio

The overall steering ratio is defined as degrees of steering wheel angle divided by corresponding front wheel angle. For race cars it varies from over 20:1(slow) for Superspeedway cars to less than 10:1(very fast) for Formula One cars on tight street circuits. Usually the steering ratio for go-kart is 1:1. Common values in road racing are 16:1to 18:1. And the steering ratio of our go-kart is kept 1:1.

D. Advantages of four bar Ackermann mechanism

- This mechanism helps us in attaining maximum cornering speed, without the slippage of tires.
- This also gives us minimum turning radius, helping us to take sharp turns when the driver has to take sharp corners.
- Steering ratio is 1:1, which is very useful and mandatory for racing.
- The energy required by the driver is low while steering, when compared to the other steering mechanisms.
- As this mechanism contains no gears and 4 links, it is quite easy to compared to the other mechanisms.

II. GEOMETRY

The 1st thing in steering design is deciding the geometry. As stated above we decided to go with the Ackermann Geometry and designed the same for our vehicle. The process is as follows:

A. Inputs

As per the rulebook of the competition, the only inputs we had were the Wheelbase and Trackwidth of the kart.

We selected the following values considering the overall design of the kart-

Wheelbase- 48 inches

Trackwidth- 36 inches

B. Parameters

The various parameters on which the geometry depends are listed below:

1. Stub Axle Length
2. Steering Arm Length
3. Angle Between Stub Axle and Steering Arm
4. Dimensions of Triangular Plate
5. Dimensions of Tie-rod

The geometry obtained initially by some assumed parameters was not quite accurate. We followed the trial and error method to find the optimum combination of the values of these parameters. This method was carried out in SOLIDWORKS Sketcher. By this process, we arrived at a precise geometry.

C. Final Dimensions

The final dimensions or the driving parameters are as follows-

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 05, May-2016

1. Stub Axle Length - 6.25 in
2. Steering Arm Length – 3.5 in
3. Angle Between Stub Axle and Steering Arm – 95 degrees
4. Dimensions of Triangular Plate –
   Base- 3 in
   Height- 3.25 in
5. Dimensions of Tie-rod -12.7 in

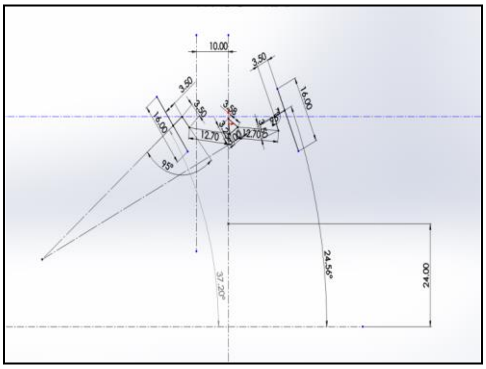

Fig.3. Final Ackermann Geometry in SOLIDWORKS

D. *CAD Models*

The next step after the geometry design is the CAD modelling of all the components considering the material to be used for each component. We have used SOLIDWORKS for this purpose.

The components are as follows-

A. *Stub and Steering Arm(Elliot)*

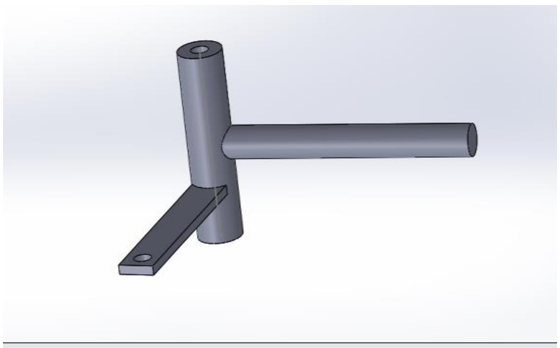

Fig.4. Stub and Steering Arm

B. *Triangular Plate*

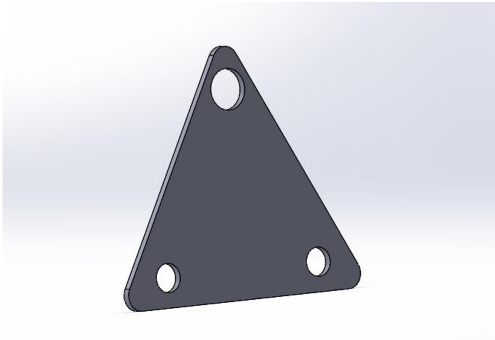

Fig.5. Triangular Plate

C. *Tie Rod*

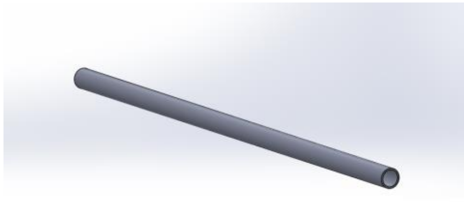

Fig.6. Tie Rod

D. *Rose Joints*

Fig.7. Rose Joint

E. *Steering Wheel*

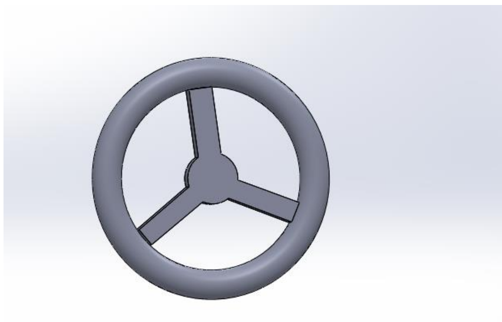

Fig.8. Steering Wheel

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 05, May-2016

F. *Final Assembly*

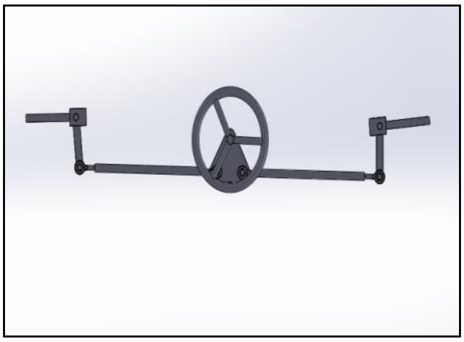

Fig.9. Steering assembly (Top view)

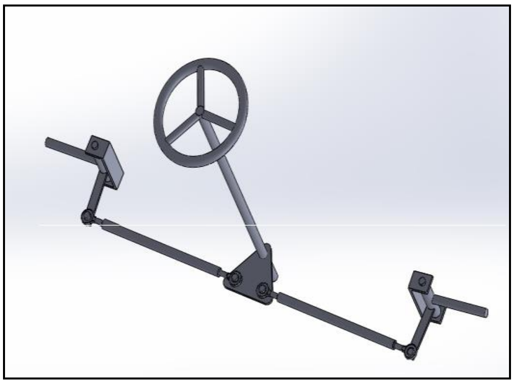

Fig.10. Steering Assembly (Isometric view)

III. MANUFACTURING

According to the above design, we manufactured the components considering the material and were later mounted onto the final chassis.

Fig.11. Steering System manufactured and mounted on the vehicle.

IV. CONCLUSION

Various concepts related to steering system were studied. Four Bar Linkage Ackermann Geometry was designed in SOLIDWORKS by varying the different parameters until a precise geometry was obtained. After obtaining the final dimensions of all the components, CAD models of these components were designed and assembled in SOLIDWORKS, and then manufactured respectively. An optimal procedure was followed and hence can be considered as a standard procedure for designing steering system of small vehicles like Go-Karts.

V. REFERENCES

[1] Deep Shrivastava, ‘Designing of All Terrain Vehicle (ATV)’, International Journal of Scientific and Research Publications, Volume 4, Issue 12, December 2014, ISSN 2250-3153.

[2] Alfred Showers and Ho-Hoon Lee, Design of the Steering System of an SELU Mini Baja Car, International Journal of Engineering Research & Technology (IJERT) Vol. 2 Issue 10, October – 2013, ISSN: 2278-0181

[3] Dale Thompson, www.racing-car-technology.com.au/Steering Ackerman4.doc

[4] Leslie Rayner, Steering Design for a Formula SAE-A Open Wheel Race Car, University of Southern Queensland, October, 2004

[5] Aritra Nath, C. Jagadeesh Vikram, Lalchhanchhuah, Lalrinsanga, Lamphrang Nongrum and Philick Marboh, Design and Fabrication of a Go Kart, International Journal of Innovative Research in Science, Engineering and Technology, Vol. 4, Issue 9, September 2015, ISSN(Online) :2319-8753, ISSN (Print): 2347-6710

[6] Jing-Shan Zhao, Xiang Liu, Zhi-Zing Feng and Jian S. Dai, Design of Ackermann Type Steering Mechanism, Journal of Mechanical Engineering Science, 2013.