Advanced Four Wheel Steering System

Bhupendra Pratap Singh[1], Brijesh Kumar Yadav[2], Lal Bahadur Singh[3], Badri Vishal[4], Raj Kumar Yadav[5] Mr.Ram Pratap Yadav[6], Mr.Rahul Srivastav[7]

[1,2,3,4,5]B.Tech students, [6]Assistant professor,[7]Lecturer, Department of Mechanical Engineering, BIT, GIDAGorakhpur(U.P.) India

ABSTRACT

The aim of this project is to decrease the turning radius of the vehicle using four wheels symmetric steering system (4WS). The system being analyzed here is a mechanical linkage between the front and the rear. The use of a simple kinematic bar mechanism connecting the front and rear hub making the rear wheel to turn in an opposite direction as the front wheels are turned thereby performing the task of reducing the turning radius of the vehicle. In situations like low speed cornering, vehicle parking and driving in city conditions with heavy traffic in tight spaces, driving would be very difficult due to vehicle's larger wheelbase and track width. Hence there is a requirement of amechanism which result in less turning radius and it can be achieved by implementing four wheel steering mechanism instead of regular two wheel steering. The prototype was tested for its cornering ability through constant radius test and was found 40% reduction inturning radius and the vehicle was operated at low speed of 10 kmph.

KEYWORDS: Four-Wheel Steering, 4WS, Rear Wheels Control, Turning radius optimization.

1. INTRODUCTION

Steering is a system that is used in most type of transport to control the movement ofthe vehicle. The steering system allows the driver to guide the moving vehicle on the road and turn it right or leftas desired. The vehicle is equipped with four wheel steering system; it will be easy for the driver to actually make the turn with ease even in the small space that is available for him. But the main thing is that we have two configurations in four wheel steering systems called same phase and opposite phase. In order to reduce the turning radius of the vehicle, we need the opposite phase configuration of four wheel steering system.

The main aim of this project is to reduce the turning radius of a vehicle as much as practically possible without crossing the practical limits of design and assembly of the components of the steering system. Based on these requirements, a four wheel symmetric steering system is analyses using kinematic approach and a conclusion is drawn regarding the geometry of the optimum steering system and the effect of this on the turning radius of the vehicle. This system is seen not to cross any practical limitations of the vehicle in terms of assembly and spacing.

2. STEERING PRINCIPLE

According to Ackerman steering system, 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. The intention of Ackermann geometry is to avoid the need for tyres to slip sideways when following the path around a curve. The geometrical solution to this is for all wheels to have their axles arranged as radii of a circle with a common centre point. In two wheel steering as the rear wheels are fixed, this centre point must be on a line extended from the rear axle. Intersecting the axes of the front wheels on this line as well requires that the inside front wheel is turned, when steering, through a greater angle than the outside wheel. Ackerman condition for a front wheel steering system, the difference of the cotangents of the angles of the front outer to the inner wheels should be equal to the ratio of width and length of the vehicle being considered as shown in fig. The terms δo represents outer wheel angle and δi represents inner wheel angle. The term w represents the wheel track and l represents wheel base.

IJREAT International Journal of Research in Engineering & Advanced Technology, Volume 3, Issue 2, April-May, 2015
ISSN: 2320 – 8791 (Impact Factor: 2.317)
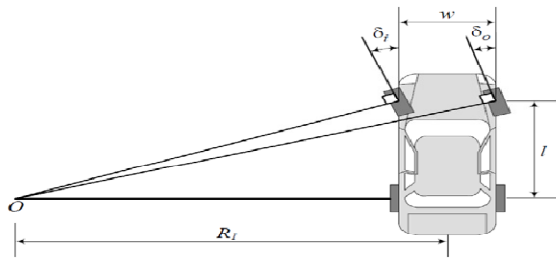**www.ijreat.org**

Fig. Steering illustration

$$[\cot\delta_o - \cot\delta_i = w/l]$$

3. TURNING RADIUS

The turning radius or turning circle of a vehicle is the diameter of the smallest circularturn that the vehicle is capable of making.
Turning circle radius = (track/2) + (wheelbase/ sin (average steer angle))

3.1 UNDERSTEER

When the slip angle of front wheels is greater than slip angle of rear wheels vehicle under steers. Thus the vehicle goes out of the circle of steering. Most vehicles manufacturers set the vehicle profile with some understeer.
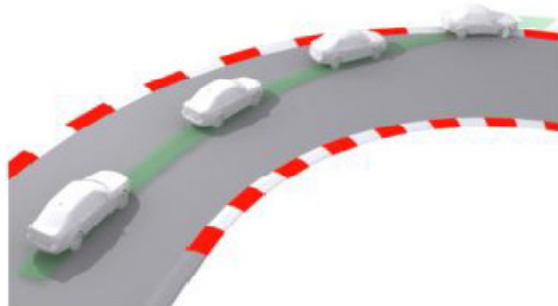

Fig.Understeer

3.2 OVERSTEER

Over steer is defined when the slip angle of front wheel is less than the slip angle of rear wheel. This makes the vehicle move inside the circle of steer. This is a fardangerous situation than understeer.

Fig.Oversteer

3.3 COUNTERSTEER

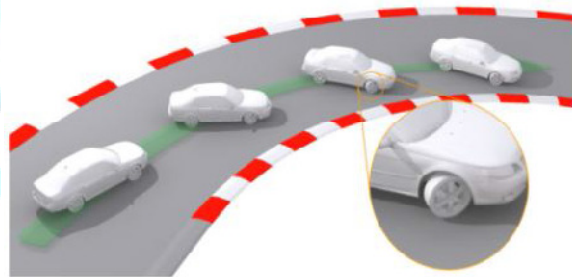Counter-steering can defined as when the slip angle of front wheels is equal to slip angle of rear wheel.

Fig.Countersteer

4. COMPARED OF 4WS SYSTEM WITH 2WS CONVENTIONAL SYSTEM.

Car more efficient and stable on cornering.
Improved steering responsiveness and precision .
High speed straight line stability.
Notable improvement in rapid, easier, safer lane changing maneuvers.
Smaller turning radius and tight space maneuverability at low speed.
Relative Wheel Angles and their Control.
Risk of hitting an obstacle is greatly reduced.

5. STEERING WHEEL CONFIGURATION
(i)Two Wheel Steer :
A Four Wheel Steering System is flexible enough to work as a two wheel steer by restricting the rear wheel movement.
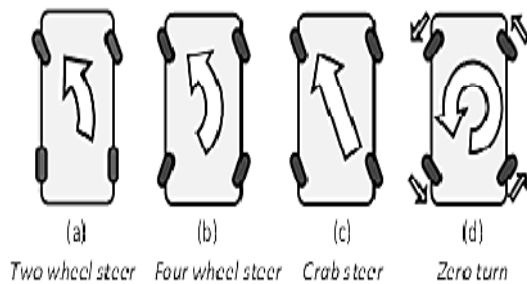**(ii)Four wheel steer:**

Front wheel directions are opposite to rear wheel directions.This helps to take sharp turn with least turning radius. This is done at slow speed.

(iii) Crab Steer :
At high speed lane change, both the front and rear wheels face in same direction.

(iv) Zero turn:
Front and Rear wheels are so aligned that the vehicle moves in acircle of ''zero radius''.

(a) Two wheel steer (b) Four wheel steer (c) Crab steer (d) Zero turn

6. FOURWHEELSTEERING TYPES

There are two types of four wheel steering configurations.

  (i)   **Positive Four Wheel Steering System**
  (ii)   **Negative Four Wheel Steering System**

Positive Four Wheel Steering System

In the positive four wheel steering
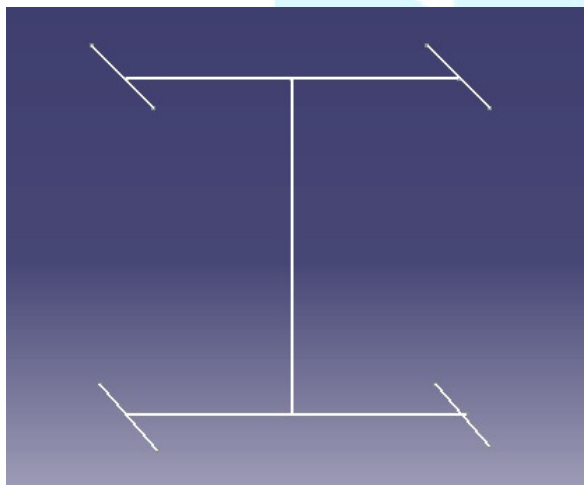both the front and the rear wheels turn in the same direction.

Fig.Positive four steering

Negative Four Wheel Steering System

In the negative four steering system both the front and the rear wheels turn in opposite to each other is called negative four wheel steering system.
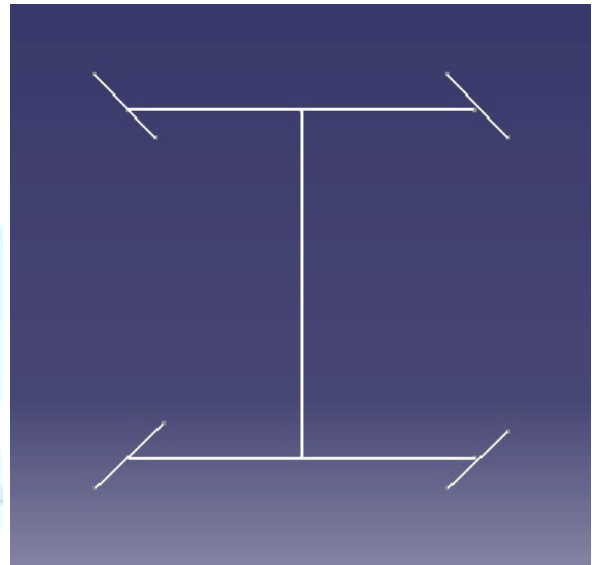

Fig. Negative four wheel steering

7. TURNING CIRCLE MEASUREMENT

Turning circle measurement as per Indian Standards , the turning circle is measured by drawing a circle on which the outer most wheel moves when the steering wheel is turned to the maximum lock and the vehicle moving at a speed below 10km/h.

Case study of four wheel steering

A case study on the steered wheel angles of a vehicle is done to find the usefulness of the symmetric four wheel steering system in reducing the turning radius of the vehicle compared to its counterpart i.e. the normal front wheel steering system in which only the front wheels are steered.

The data of the vehicle considered are as follows

Wheel Base :   680mm
Wheel Track :   460mm (approx.)
Turning radius :   1234.795mm

IJREAT International Journal of Research in Engineering & Advanced Technology, Volume 3, Issue 2, April-May, 2015
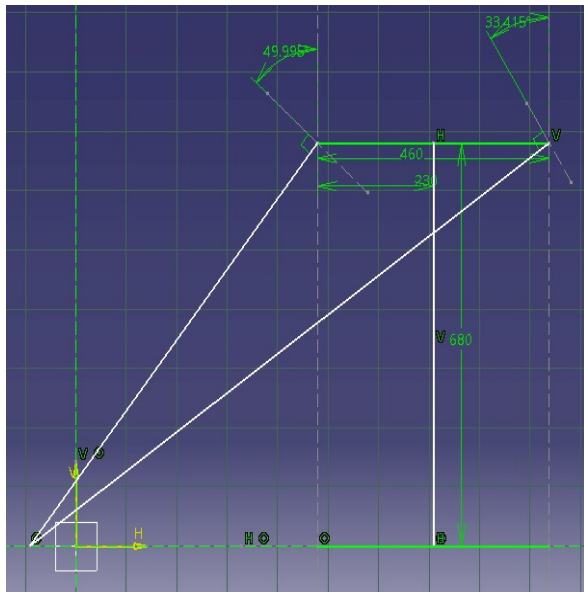ISSN: 2320 – 8791 (Impact Factor: 2.317)
www.ijreat.org

Fig.Steered fornt wheel angle measurment

Initially only the front wheel steering is considered to find out the angles of the front two wheels at the given turning radius value in the car brochure considering the vehicle wheel base and track values.

Now, keeping one of the angles constant and applying four wheel symmetric steering to this vehicle and measuring the other wheel angle for symmetric four wheel steering geometry, we get the following as the resultant turning radius using this system.
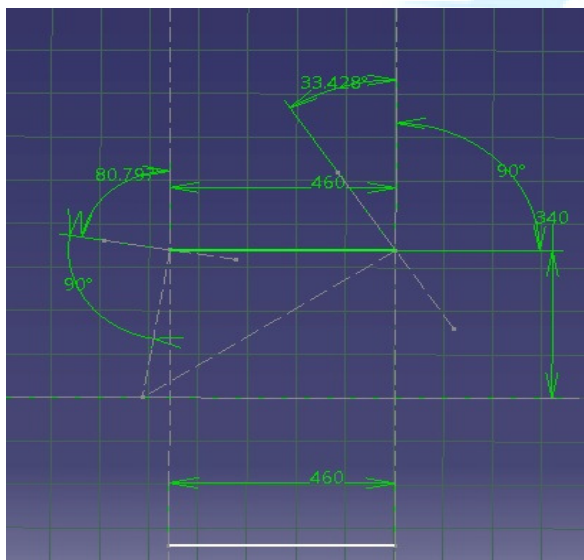

Fig. Modified steering wheels angles 1

Now, keeping the other angle constant and applying four wheel symmetric steering to this vehicle and measuring the other wheel angle for symmetric four wheel steering geometry, we get the following as the resultant turning radius using this system.
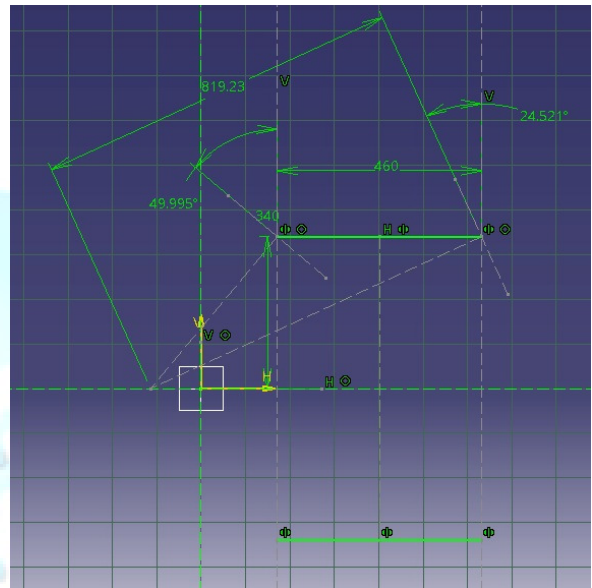

Fig.Modified steering wheels angles 2

Out of the two observations, it is evident that the second system gives the optimum turning radius without exceeding the practical limitations of the vehicle which is the turning of the inner wheel to an angle of 80.1⁰ to one extreme.
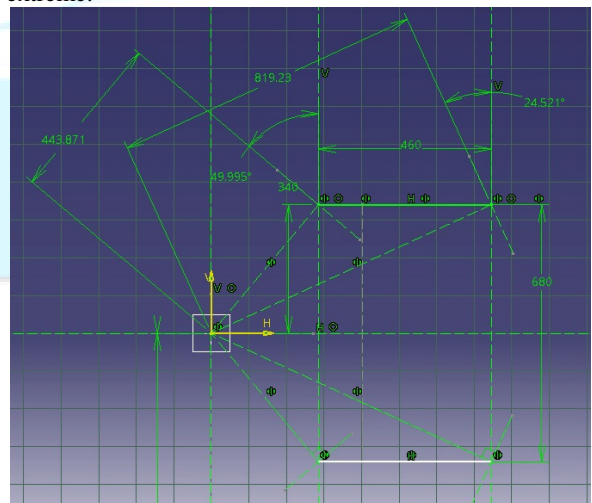

Fig. Optimum symmetric four wheel steering

The optimum steering wheel angles practically suitable for a vehicle to reduce the turning radius of the vehicle.

This optimum configuration gives 34% reduction of the turning radius for this vehicle.

8. ADVANTAGE

- Turning radius of the vehicle can be reduced and better parking.
- Better handling in tight corners.
- Improved steering response.
- Stability of the vehicle increase at low speed.
- Better high speed maneovers .
- Better straight line stability.
- Improved corning performance

9. LIMITATIONS

The effect that it produces is not felt significantly at low speed or in commercial carsbut in heavy vehicles like trucks and towing vans it provides significant lane changing and low speed manoeuvrability. Its mechanism is extensively complex. Althoughmany designs have been brought forward so far, none has the right combination ofsimple design, low maintenance with low cost.

CONCLUSION

Thus, the four wheel steering system has got cornering capability, steering response, straight linestability, lane changing and low speed maneuverability. Even though it is advantageous over the conventional two wheel steering system, four wheel steering is a complex and expensive. Currently, the cost of a vehicle with four wheel steering is more than that of the conventional two wheel steering ofvehicle. Four wheel steering is growing in popularity and it is likely to come in more and more new vehicles. As the system become more common place, the cost of four wheel steering system will drop down.

REFERENCE

[1] H. Sakai, T. Matsuo, S. Murayama, H. Hoshino, and R. Nagashima,Utsunomiya University, Utsunomiya, Japan

[2]Indian Standards - 12222

[3]D.S.CHOUDHARI ,Assistant Professor, Department of Mechanical Engineering, Atmiya Institute of Technology andScience, Rajkot, Gujrat 4WS ISSN 2774785

[4]Institute for Dynamic System and Controls, Steering Dynamics

[5]Unknown, Four Wheel Steering System, http://www.docstoc.com/docs/73259901/Four-Wheel-Steering-System

[6]"Control System of vehicle model with Four Wheel Steering" by P.Brabec, M.Maly, R.Vpzenilek.