

## FOUR WHEEL STEERING SYSTEM

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### ABSTRACT

This paper report on four wheel steering system by using rack and pinion mechanism. This system converts the steering rotational motion into linear motion to turn the wheels. The four wheel steering system is completely different from two wheel steering system. In this system, power transferred from front axle to rear axle by using rack and pinion method with rod. It reduces the turning radius and also space required for turning. Four wheel steering is a system employed by some vehicles to improve steering response, increase vehicle stability while steering at high speed and to decrease turning radius at low speed. It is helpful in avoiding skidding as well as parking problems occurs in metro cities, in traffic and in rural areas. A four wheel steering system is superior to a two wheel steering system. This type of system can be applicable to all types of special utility vehicles. In most active four wheel steering systems, the rear wheels are steered by activators and coupling arrangement. Because of large work load on front wheels and uneven tire wears of vehicle this system does not getting popularity. In order to achieve this, a mechanism which consists of two rack and pinion and intermediate shaft which transmit 100% torque as well turns rear wheels in out of phase was developed. The mechanism was modeled using SOLID WORK and the motion simulation and analysis was done using SOLID WORK and ANSYS.

**Keywords:** Rack and pinion, four wheel steering, turning radius, stability, handling.

### INTRODUCTION

Four wheel steering is a method developed in automobile industry for the effective turning of the vehicle and to increase the maneuverability. In a typical front wheel steering system the rear wheels do not turn in the direction of the curve and thus curb on the efficiency of the steering. In four wheel steering the rear wheels turn with the front wheels thus increasing the efficiency of the vehicle. The direction of steering the rear wheels relative to the front wheels depends on the operating conditions. At low speed wheel movement is pronounced, so that rear wheels are steered in the opposite direction to that of front wheels. At high speed, when steering adjustments are subtle, the front wheels and the rear wheels turn in the same direction reduction in turning radius of the vehicle which is efficient in parking, low speed cornering and high speed lane change. In city driving conditions the vehicle with higher wheelbase and track width face problems of turning as the space is confined, the same problem is faced in low speed cornering. Usually customers pick the vehicle with higher wheelbase and track

width for their comfort and face these problems, so to overcome this problem a concept of four wheel steering can be adopted in the vehicle. Four wheel steering reduces the turning radius of the vehicle which is effective in confined space, in this project four wheel steering is adopted for the existing vehicle and turning radius is reduced without changing the dimension of the vehicle. Steering is the term applied to the collection of components, linkages, etc. which will allow a vessel (ship or Boat) or vehicle to follow the desired course. An exception is the case of rail transport by which rail tracks combined together with railroad switches provide steering column, which may contain universal joints, to allow it to deviate somewhat from a straight line. The most conventional steering arrangement is to turn the front wheels using a hand-operated steering wheel which is positioned in front of the driver.

## **II. LITRATURE SURVEY**

*We preferred many research papers, reference books related to this topic and review papers. By observing that a lots of information and ideas regarding our concept. Some of these papers are described below:*

1. Arun Singh and Abhishek Kumar at al. (2006) work on the stability of four-wheel-steering system. In this research they observed Automobile industry is widely used two wheel steering system. But, four wheel steering system has many advantages which are very useful as compared to two wheel steering system still 4WS has not widely used. In four wheel steering system, all the four wheels are steered by driver to take a sharp turn for parking purpose or in a traffic situation. Four wheel steering system is not a new technology but it has not gained more popularity than two wheel steering system even though experimental results has told that four wheel steering system is more suitable than two wheel steering system. Because the turning radius of any four wheel vehicle is decreased by the implementation of four wheel steering system. Four wheel steering system has excellent maneuverability, high stability and it is a solution to over steer/under steer. Due to four wheel steering system, driver can easily control and steer the car and decrease the driver effort. In this project, we developed an effective four wheel steering system which gives a better result at low and high speed. So, it increases maneuverability, stability and also used to decrease turning radius and driver effort. It also works intrafficand parking condition. There are the following results that we obtained from the experimental testing of model. Turning Radius is decrease By calculation 5.394m to 2.099M and By experimental 4.42m to 2.00 m.

2. Arvind at al.(2013) work on Optimizing the turning radius of a vehicle using symmetric four wheel steering system. The main objective 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 axle with a rack and pinion steering system at both the ends. This mechanical system is studied by kinematic analysis of the steering system geometry and the turning radius is calculated for a vehicle with and without this four wheel symmetric steering. These measurements are compared to know the effect of the system on the vehicle in terms of the turning radius .From the kinematic analysis it is evident that the turning radius of the vehicle can be reduced up to 35% by using four wheel symmetric steering system without crossing the practical limitations.

3. Saket Bhishikar et al.(2014) work on In standard 2 Wheel Steering System, the rear set of wheels are always directed forward and do not play an active role in controlling the steering. While in 4 Wheel Steering System, the rear wheels do play an active role for steering, which can be guided at high as well as low speeds. Production cars are designed to under steer and rarely do they over steer. If a car could automatically compensate for an under steer/over steer problem, the driver would enjoy nearly neutral steering under varying operating conditions. Also 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 a sedan's larger wheelbase and track width. Hence there is a requirement of a mechanism which result in less turning radius. We have developed an innovative 4 wheel steering design to implement a mechanism that can serve the purpose of changing in-phase and counter-phase steering of rear wheels depending upon the conditions of turning and lane changing with respect to front wheels, thus enhancing the maneuverability of a sedan in accordance with its speed. Our 4 Wheel Steering System gives 64.4% reduction in turning circle radius of a sedan which is reduced from 5.394m to 1.92m, considering HONDA CIVIC as a standard car for our calculations, and steering ratio thereby obtained is 8.177:1 which gives much better maneuverability and control on the car even while driving at high speeds.

4. Dishank Bari et al.(2014) work on Design and manufacturing of a system to measure the turning radius of Vehicle. Production cars are designed to under steer and rarely do them over steer. If a car could automatically compensate for an under steer/over steer problem, the driver would enjoy nearly neutral steering under varying operating conditions. Four-wheel steering is a serious effort on the part of automotive design engineers to provide near-neutral steering. Also 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 a mechanism which result in less turning radius and it can be achieved by implementing four wheel steering mechanism instead of regular two wheel steering. Our 4 Wheel Steering System gives 39.56% reduction in turning circle radius of a hatchback which is reduced from 4.6 m to 2.78 m, considering Maruti Suzuki ALTO 800 Turning Radius Four wheel steering Two wheel steering By calculation 2.78 m 4.6 m 4. From the kinematic analysis it is evident that the turning radius of the vehicle can be reduced up to 39.56% by using four wheel symmetric steering system without crossing the practical limitations.

5. Mr. Krishna Bevinakatt et al. (2015) work on the A Four wheel steering system also known as Quadra steering system. In this paper, both front wheel and rear wheels can be steered according to speed other vehicle and space available for turning. Quadra steer gives full size vehicle greater ease while driving at low speed, improves stability, handling and control at higher speed. Production-built cars tend to under steer or, in few instances, oversteer. If a car could automatically compensate for an under steer oversteer problem, the driver would enjoy nearly neutral steering under varying conditions. Four wheel systems is a serious effort on the part of automotive design engineers to provide near-neutral steering. This system finds application in off-highway vehicles such as forklifts, agricultural and construction equipment mining machinery also in Heavy Motor

Vehicles. It is also useful in passenger cars. It improves handling and helps the vehicle make tighter turns. This system is used to minimize the turning radius. It is observed that when Maruti 800 during turning actual turning radius is 14.70ft. But after making modification in the four wheels steering system it is measured as 5.14ft. hence we conclude that after making modification the turning radius is reduced more than half.

### III. METHODOLOGY

In this project working of four wheel steering system with the help of rack and pinion mechanism to reduce the turning radius and increase the stability at the time of drive or turning. A steering wheel connected with shaft, which is attached with the pinion which is connected to rack. In a model use two rack and three pinion .when steer the steering then a rack and pinion mechanism work with the help of shaft which is shown in figures.

#### 3.1. BASE FRAME STRUCTURE

A vehicle frame is the main supporting structure of a motor vehicle to which all other component is attached. For building of prototype model the designed model is considered with that a frame is built to support the steering and seat. The frame is designed considering the wheelbase. Seat is joint to the frame. The frame also takes the road load and load of drivers considering all the factors the frame is designed and developed.

#### 3.2. CONNECTION DESIGN OF STEERING TO WHEEL SHAFT

This is the shows the connection of the steering to wheel shaft. In the wheel shaft attached the rack in two sides such as upper and front side, which is moved by the help of pinion attached in a steering shaft.

### IV. FIGURES AND TABLES

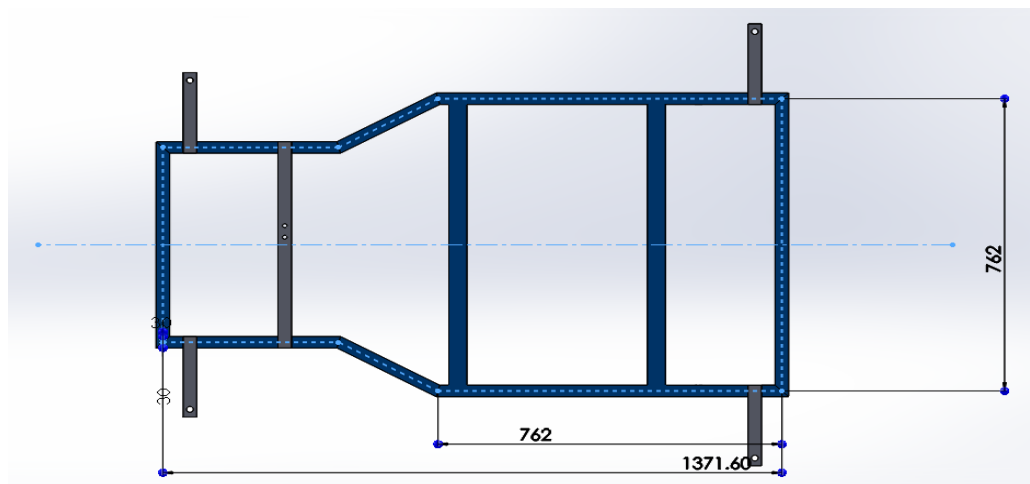
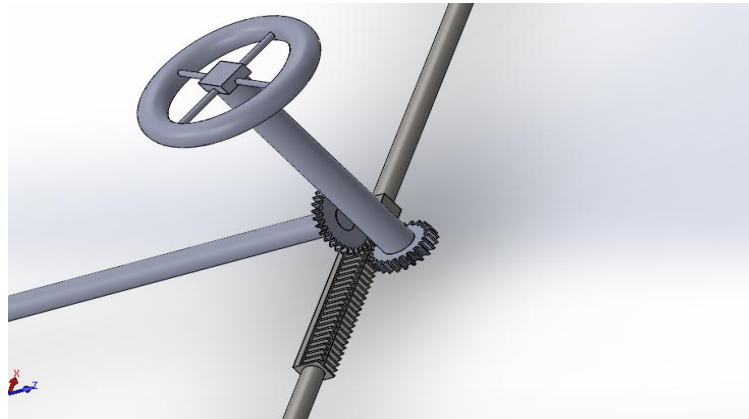
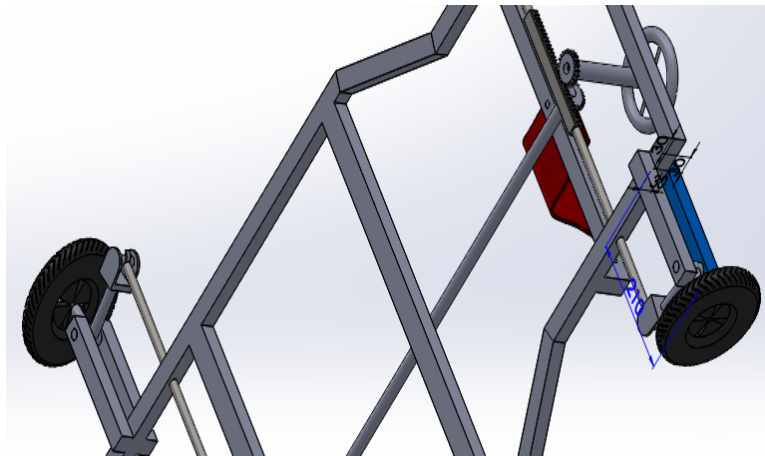


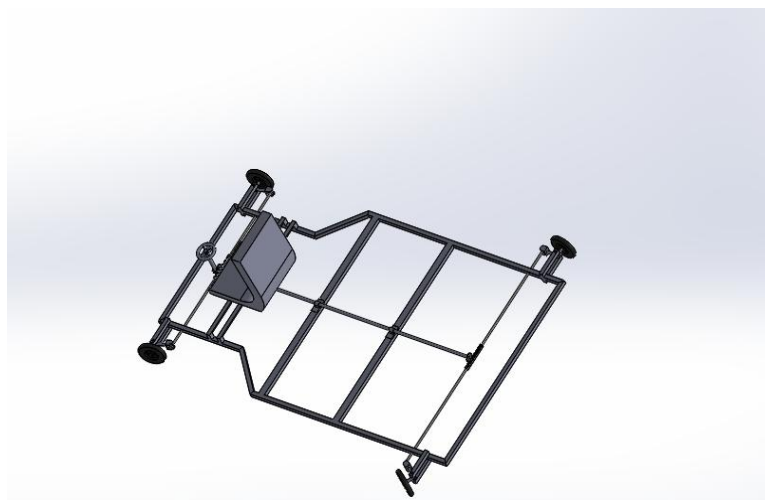
Fig 1 - base frame structure



*Fig 2- connection design of steering to wheel shaft*



*Fig 3- design of wheel connection*



*Fig 4- model after creating joints*

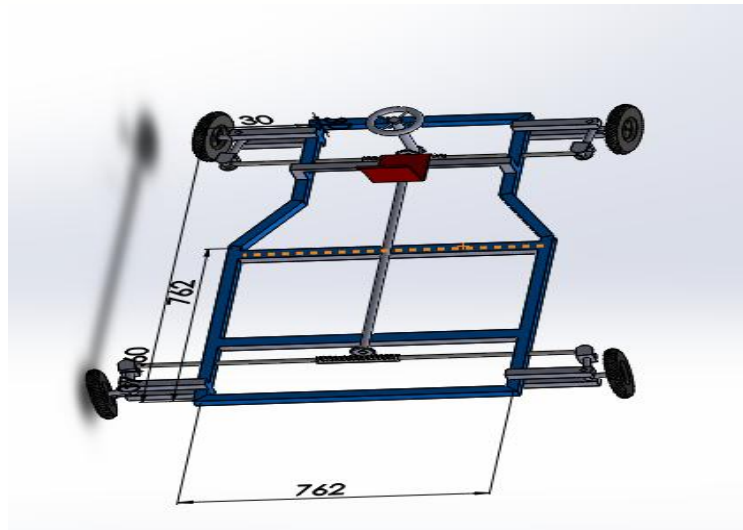


Fig 5-final model after creating joints

Turning radius	2-wheel steering	Old 4-wheel steering	Now 4-wheel steering
By conclusion	4.4 m	2.59 m	2.4 m
By experiment	5.57 m	2.85 m	2.65 m

Table 1- compression between 2 wheels to 4 wheels steering system

## V. DISCUSSION

The vehicles cornering behavior becomes more stable and controllable at high speeds as well as on slippery road or wet surfaces. The vehicles response to steering input becomes more precise and quicker throughout the vehicles entire speed range. The vehicles straight-line stability at high speeds is improved. Negative effects of road crosswinds and irregularities on the vehicles stability are minimized. The vehicle is less likely to go into a spin even in situations in which the driver must make a relatively large and sudden change of direction. By steering the rear wheels in the direction opposite the front wheels at low speeds, the vehicles turning circle radius is greatly reduced. Therefore, vehicle driving on narrow roads and during parking becomes easier.

## VI. CONCLUSION

1. By this experiment, we can conclude that there is 54.5 % reduction in turning radius and by experiment it's 47.5%.
2. Turning radius achieved with two wheel steering is 5.75m and turning radius achieved with four wheel steering is 2.65 m.

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