



## Design and Development of Steering Wheel Mechanism in Electric Vehicle

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**Abstract**— Vehicle Control is main essential part of automobile; without control we can't handle vehicle. Nowadays most of the four-wheeler are having steering system which is based on Ackermann principle. Steering system which is used to steer the front wheels of vehicle with driver inputs in order to provide overall directional control of the vehicle. Thus, Steering system play very important role in handling of vehicle. Steering mechanism invented by the Ackermann allowing the vehicle to turn along the flow of the path as Ackermann steering. The steering system is firstly used to control the direction of the vehicle.

In our system pitman arm plays a very important role in steering system as it transmits the steering movement to the wheel. The Pitman arm is an attached linkage to tie rod which converts the angular motion of the steering wheel shaft into the linear motion which is needed to steer the wheels of vehicle

**Keywords**— Ackermann geometry, Camber angle, Castor angle, Kingpin inclination, Toe angles, Types of steering, Steering ratio, Steering effort, Effect of centrifugal force, Over steer, Under steer, Steering Wheel, Steering Column, Tie rod, Pitman Arm, Knuckle.

### I. INTRODUCTION

System is to provide the directional control to the vehicle by minimizing the input of driver. Thus, the Steering mechanism also plays an important role in to transmit the steering movements to the wheel. Also, it should be with stand the stresses generated while sharp cornering, jounce and rebound of the front wheel. The function of steering wheel system is to convert the rotating motion of steering wheels into angular displacement of front wheels. The steering mechanism also used to maintain the straight direction of vehicle while it also avoids road shocks and pits and should operate with minimum effort during driving of the vehicle.

The main purpose of the steering system is to provide directional control of the vehicle with minimum input effort. The steering is designed to withstand the stress of the vehicle through any type of possible condition at the time of driving. The main concern about steering is, that it should be according to "Ackermann" condition of correct steering. While designing, the main thing is that to keep in mind is simplicity of the system. Therefore, system should be light in weight, less play, should give a quick response to the driver, and better-running feedback. Thus, we are using Ackermann geometry.

The main thing about steering system is to follow the Ackerman Steering condition for slow speed with no slip angle. Designer should be considering the mechanism should have less play, quick response, type of suspension, space availability, manufacturing cost and weight of the system. When steering wheel is turned, the steering column gives the motion to the steering axis. The steering axis is connected to the links of the steering mechanism, which is at the centre of system. The moving links changes the direction of the wheels by transferring motion to the link that is attached to the wheels of system. This is how Ackermann's steering kinematics works. It is referred as kinematics because Ackermann's principle of steering doesn't in influence of any external forces. The relative motion only involved between force links and does not involve the study of the effect of forces. The design of Ackermann steering geometry is in such a way that the two front wheels are always aligned at the common centre of the turning radius.

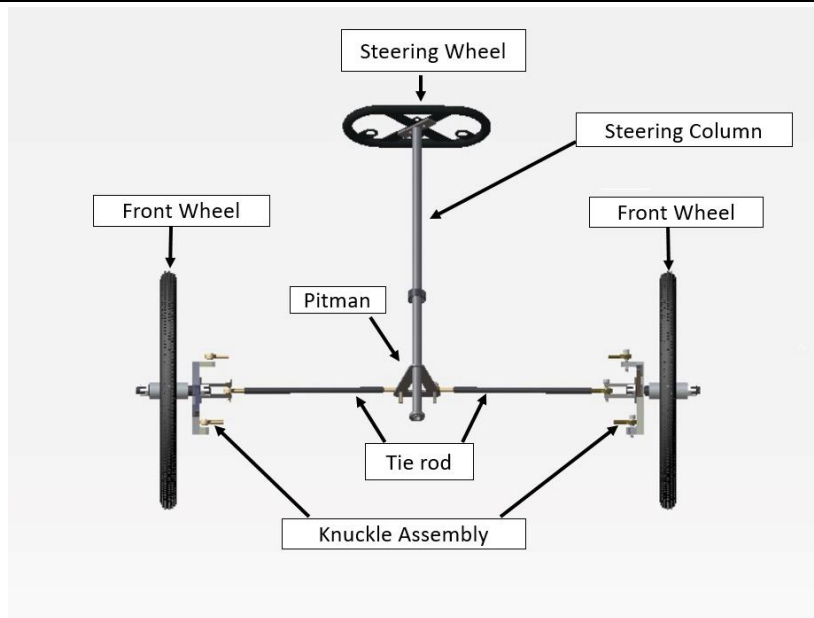


Fig. 1 Overall Steering Layout

## II. COMPONENTS OF STEERING WHEEL:

1. Steering wheel - Direct the vehicle and is connected to steering column.
2. Steering column - To transfer the motion from steering wheel.
3. Pitman Arm - Convert the angular motion to liner motion.
4. Tie Rod – Use to move steering arm.
5. Steering arm - Help to transmit the force from tie rods to make turn angle.
6. Steering knuckle - It is important part of the vehicle which connects steering, suspension, brakes, and wheel on axle to chassis. Knuckle undergoes different types loading in various conditions.

## III. LITERATURE REVIEW

[1] Vehicle Dynamics-Steering, Journal of Terramechanics, vol. 29, pp. 7- 17 D.A. Crolla and H. Schwanghart says that the many active steering vehicles still use the rack and pinion gear to implement the Ackermann steering geometry. an example is the hydraulic power steering found in large military trucks, trailers, and modern cars. Power steering basically uses the engine-driven pump and hydraulic system to give steering action, even though is human actuated or motorized

[2] Sijith PM, Prof. Shashank Gawade, Prof. S.S Kelkar carried out Performance study followed by static structural analysis and optimization to minimize the weight of the pitman arm and reducing the material cost. Optimized model is then verified by physical testing.

[3] Pavel Podany, Petr Martinek, Jana Miskova A failure investigation of fracture was conducted on pitman arm of stamping press. Fracture area was investigated by scanning of electron microscope. Detailed investigation of microstructure on the locality of fracture initiation was also performed. Article shows how crucial the heat treatment of the weld is used for prevention of the failure. Further examples of other failure analysis show the most often cause of failures due to non-conforming microstructure of material.

[4] Mr. Varad Sanjay Kumbhar<sup>1</sup>, Mr. Mangesh Vijaykumar Mali<sup>2</sup>, Mr. Nitin Parasram Banne During the turning the vehicle if I- centres of all wheels meet at a point, then the vehicle will take turn about that point which results in pure rolling action of the vehicle. The condition is called the Ackermann condition and this principle is known as Ackermann principle.

[5] Kishor C. Budhale<sup>1</sup>, Prathmesh Mahesh Daphale <sup>2</sup>, Souarabh Ravsaheb Chougule <sup>3</sup>, Hari Ananda patil <sup>4</sup>, Ashitosh Anil Mali <sup>5</sup> In Ackerman steering. Basically, the Ackerman steering mechanism reduces the steering and also reduces effort the friction and also help to take more sharp turns.

[6] Srilekha Aurulla , G. Gopala Krishna This paper presents the static and modal analysis of steering lever link to check its deformation, maximum stress and natural frequencies by using three materials.

[7] Dallin Colgrove says that the need of Ackerman condition is when the speed of the vehicle is very small, and slip angles are very close to zero. In these conditions, there would be no centrifugal force and no lateral force to balance each other. The purpose for Ackermann steering is to allow for tighter turns during low speed turning.

[8] Mayur Jamdar The Pitman Steering mechanism is simpler than any other mechanism. This mechanism gives quick response than any other mechanism. Hence, we use pitman steering mechanism. The manufacturing of Pitman Steering mechanism is simple. Pitman Steering mechanism is used because pitman mechanism gives quick response than rack and pinion mechanism.

IV. GEOMETRY DIAGRAM AND SPECIFICATION

Geometry diagram shows the actual calculation related to the Ackermann geometry that all points and calculation are covered in one diagram. All geometry calculation like castor, camber, track width, turn radius, wheel base, inner turning angle, outer turning angle, king pin inclination all others calculation and reading are covered in one geometry diagram. This diagram helps us to detect the actual reading and show all distances which we have to avoid such issues like fouling and rattling

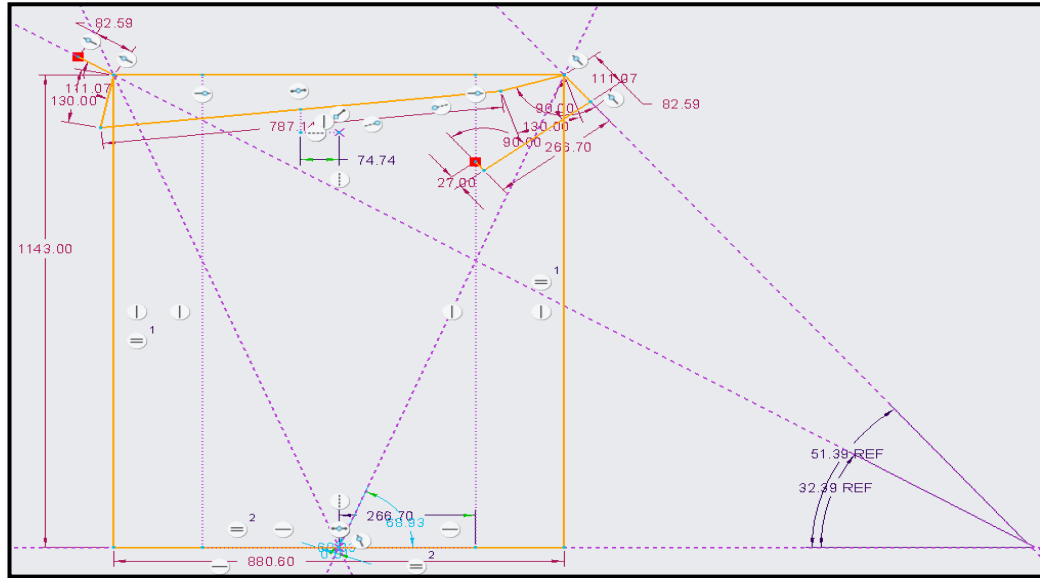


Fig. 2 Geometry Diagram

TABLE I  
GEOMETRY SPECIFICATIONS

r. No	Parameters	Values
	Track Width	880.60 mm
	Wheel Base	1143 mm
	Turn Radius	577.44 mm
	Outer Turning Angle	2.89°
	Inner Turning Angle	1.39°
	Steering Ratio	14.8:1
	King Pin Inclination	0°
	Steering Wheel Diameter	10 mm
	Steering Effort	3.25 N
0	Caster	0°
1	Camber	0°
2	Velocity	0.726 m/s
3	Height of Centre of Gravity	81 mm
4	Steering Arm	30 mm
5	Tie Rods	05 mm, 305 mm
6	Total Steering Arm	3.73°

V. CAD MODEL & ANSYS ANALYSIS

- Pitman arm: - CAD Model

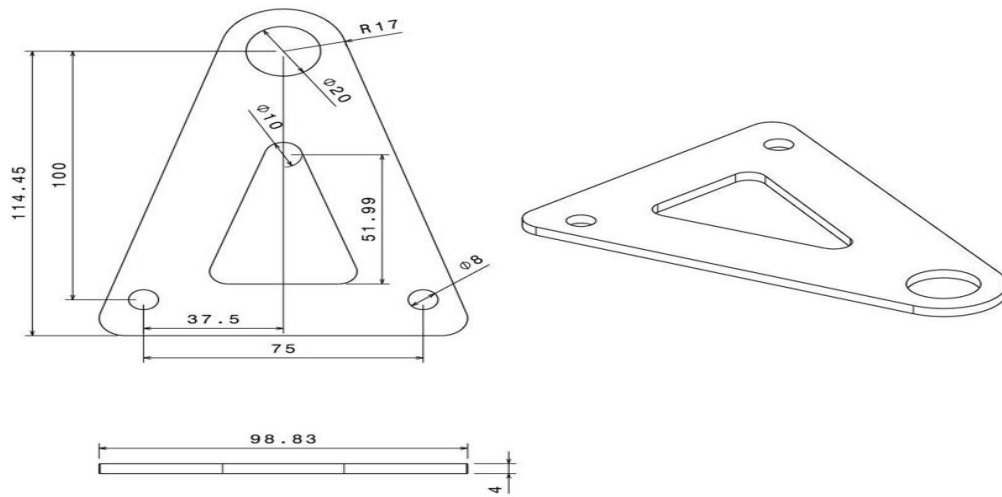


Fig. 3 Pitman arm model

- Pitmen Arm: - Ansys analysis

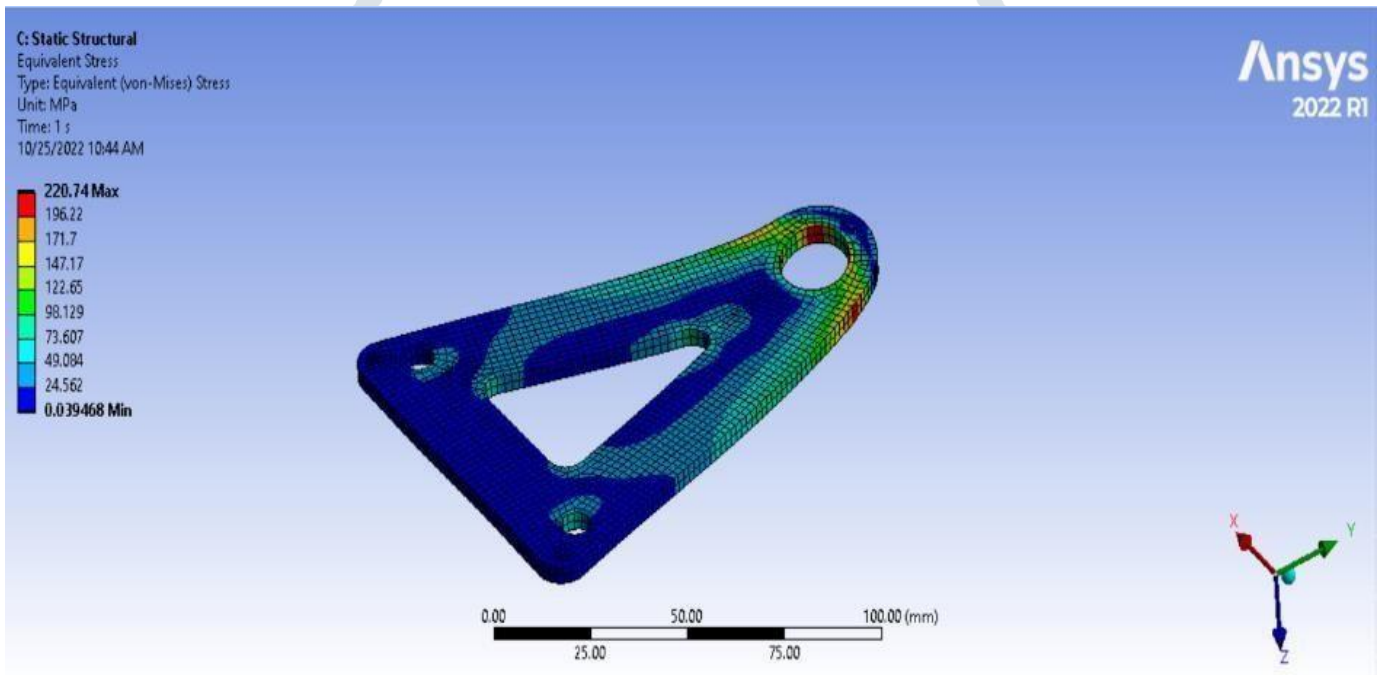


Fig. 4 Pitman Arm Analysis

- Knuckle Joint: - CAD Model

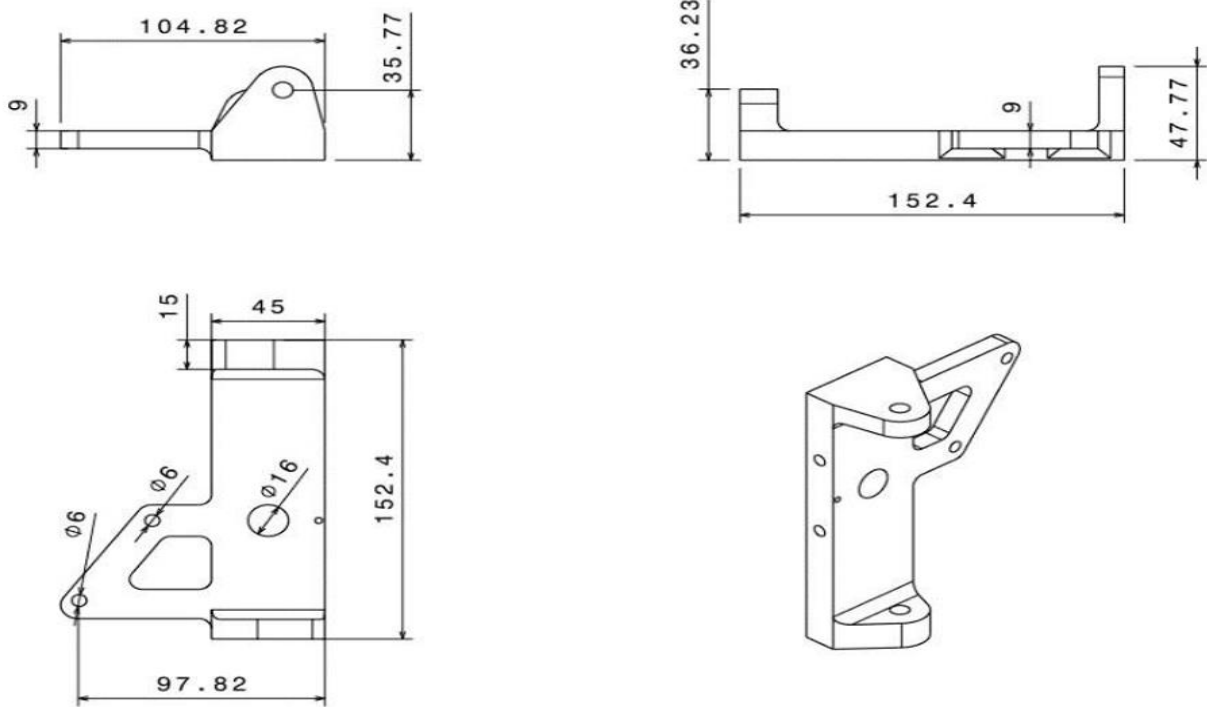
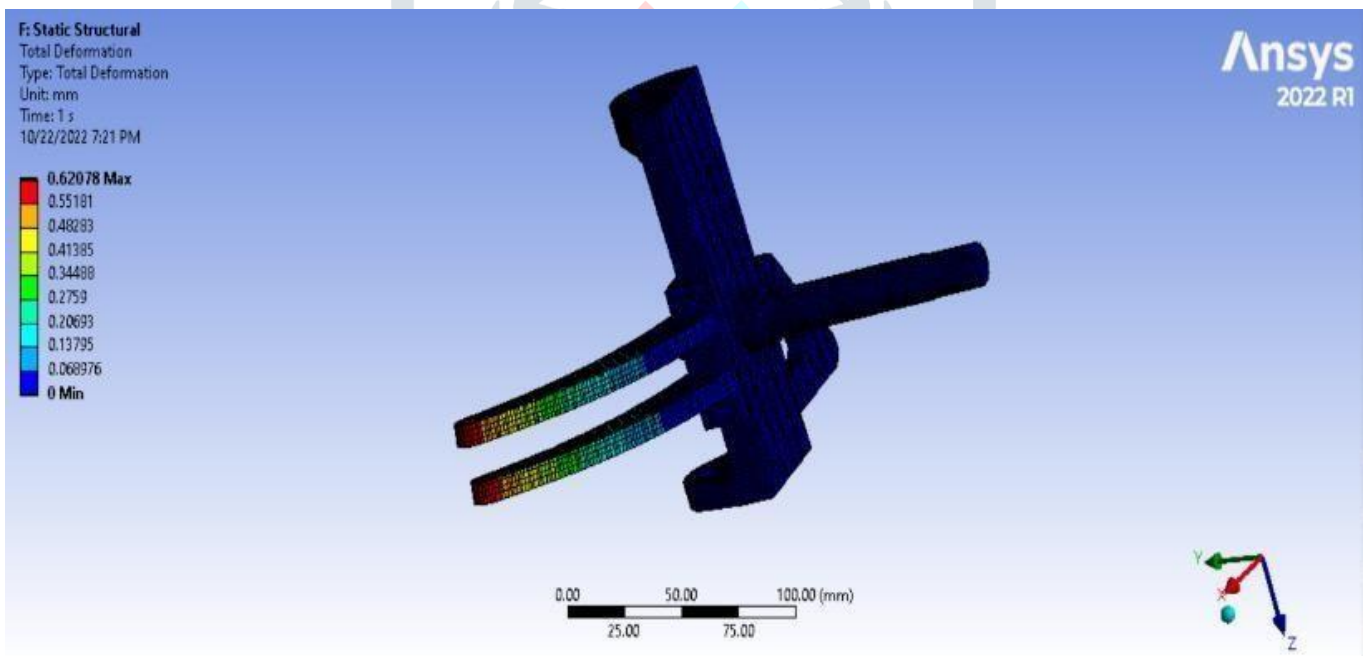


Fig. 5 Knuckle joint model

- Knuckle Joint: - Ansys analysis



• Fig. 6 Knuckle joint analysis

## VI. CONCLUSION

Steering system is the most important feature in automobile. This system will control all of the direction and movement of the wheel of our vehicle by studying all we concluded that Ackermann geometry is best suited for vehicle and Pitman steering wheel is used effectively in electric racing car. The components that are involved in this system are steering knuckle, Steering wheel, Steering Column, Tie-Rods, Pitman Arm. These components must always be in good condition so that the steering system will run smoothly and more efficiently to provide the driver with a good experience of driving on the road. It provides good handling to the driver, gives better comfort, and makes the driver less fatigued.

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