

Design and fabrication of 90 degree Steering Mechanism

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Abstract—The Soft Car design proposal has swing 90 degrees. It can pull up alongside a parking space and drive in sideways. Conventional steering mechanism involves either the use of Ackerman or Davis steering systems. The disadvantage associated with these systems is the minimum turning radius that is possible for the steering action. This difficulty that is associated with the conventional methods of steering is eliminated by employing a four wheel 90 degree steering system. This innovation promises to ease the task of parking on narrow Cambridge streets. The most striking elements of the car are wheels that incorporate electric motors and the suspension inside their circumference. By working through the problem so logically and indeed unemotionally we will anticipate discovering new possibilities. "We want to step back and rethink the automobile from scratch. Arrange steering system at front and rear side. When steering wheel will be rotate.

Keywords-Steering, 90 degree, rack and pinion, zero turning radius.

❖ INTRODUCTION

The advanced new technology has led to various modifications in the automobile sector. Out Of these, zero degree turning radius which is being analyzed in various vehicles e.g. hurricane jeep, JCB, Nano Pixel etc . The turning circle of a vehicle is the diameter described by the outside wheels when turning on full lock. There is no hard and fast formula to calculate the turning circle but it can be calculated using this; $\text{Turning circle radius} = (\text{track}/2) + (\text{wheelbase}/\sin(\text{average steer angle}))$.

Zero degree turning radius of a vehicle implies the vehicle rotating about an axis passing through the center of gravity of vehicle i.e. the vehicle turning at the same place, where it is standing. No extra space is required to turn the vehicle. So vehicle can be turned in the space equal to the length of the vehicle itself.

This technology exists in heavy earth movers like excavator which consists of two parts i.e. the upper part cabin and lower part crawler chain. The upper

part of excavator can rotate about its center, so that the direction of cabin can be changed without changing direction of lower part. Conventional steering mechanism involves either the use of Ackerman or Davis steering system.

The disadvantage associated with these systems is the minimum turning radius that is possible for the steering action. This difficulty that is associated with the conventional methods of steering is eliminated by employing a 90-degree wheel steering system. In this system vehicle front wheels will turn with help of rack and pinion as the direction of both wheels get parallel turn with 90 degree angles. Same phenomenon occurs at the rear wheels with the help of rack and pinion.

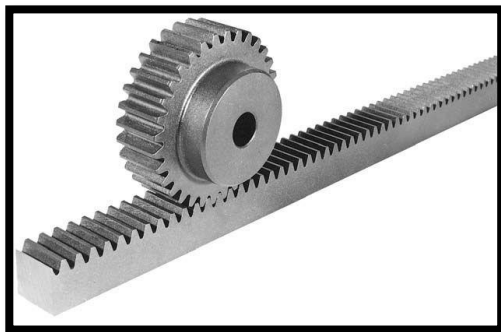
❖ **PROBLEM STATEMENT:**

The most frequently used type of steering, are using the front two wheels of the vehicle. This type of steering suffers from the comparatively larger turning circle and the extra effort required by the driver to negotiate the turn. many of the metro and urban city people are face problems in the traffic due to numbers of the vehicle and limited space for turning.



❖ **Components Used:**

1. **Rack and pinion:** A rack and pinion is a type of linear actuator that comprises a pair of gears which convert rotational motion into linear motion. A circular gear called "the pinion" engages teeth on a linear gear bar called the rack"; rotational motion applied to the pinion causes the rack to move relative to the pinion, thereby translating the rotational motion of the pinion into linear motion. Rack and pinion gears are used to convert rotation into linear motion. The flat, toothed part is the rack and the gear is the pinion.



2. **Bevel gear:** Bevel gears that have pitch angles of greater than ninety degrees have teeth that point inward and are called internal bevel gears. Bevel gears that have pitch angles of exactly 90 degree-shave teeth that point outward parallel with the axis and resemble the points on a crown.

3. **Motor drive:** DC motor is any of a class of rotary electrical machines that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current flow in part of the motor.

❖ **BASIC DESIGN CALCULATIONS:**

Length travelled by rack for 30°
rotation

$$\tan 30 = \text{Opp}/\text{Adj} = X/100$$

$$X = 58 \text{ mm}$$

For 30° of wheel rotation link has to move 58mm

Pitch of rack = 5mm

No of teeth in engagement with rack and pinion = 2

So At a time rack will move 10 mm

So 6 teeth of each rack will engage with rack to move 58 mm

As 45 no of teeth on pinion each teeth will rotate = $(360/45) = 80$

6 teeth will rotate pinion by 48°

So shaft will also rotates by 48°

The bevel gear will also rotates by 48°

So, the steering wheel has also to rotate by 48° .

By regression analysis values for different angles

Angle of rotation (degrees)	Length travelled by rack (mm)	Pitch of Rack (mm)	Teeth required to travel length	6 teeth will rotate pinion by (degrees)	Rotation of Shaft (degrees)	Rotation of bevel gear (degrees)	Rotations of steering (degrees)
20	36.39	5	4	32	32	32	32
30	58	5	6	48	48	48	48
40	83.90	5	8	64	64	64	64

❖ **Frame Design:**Material used –mild steel, square pipe

$$\text{Area}=1*1\text{inch}=25.4*25.4=645.16 \text{ mm}^2$$

$$\text{Length of link}=30'' = 760 \text{ mm}$$

$$\text{Weight of project}=10 \text{ kg}= 10*9.81 =98.1\text{N}$$

$$\text{Weight of human being } 75 \text{ Kg} = 75*9.81 = 735.75\text{N}$$

$$\text{Total load} = 833.85 \text{ N}$$

$$\text{Young's modulus}=E=210\text{GPa}$$

1. Effective length

Effective length ,when both end fixed,

$$L_e=L/2=760/2=380\text{mm}$$

2. Internal Area: Internal width and depth, which have 3 mm thickness,

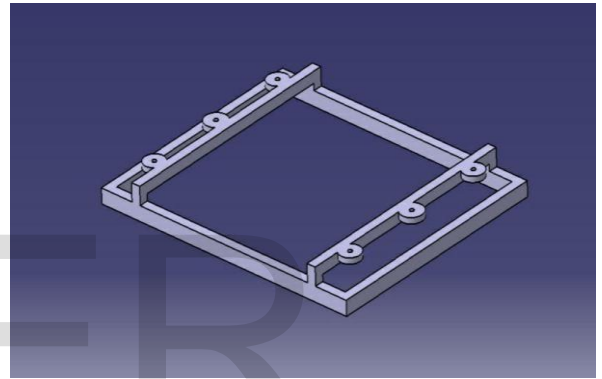
$$d=b-2*3 =19.4 \text{ mm}$$

3.Moment of inertia:

$$I=BD^3-bd^3/12 =25.4*25.4^3-19.4*19.4^3/12 =22882.048\text{mm}^4$$

4.Crippling load by Euler's formula:

$$P_c=\pi^2EI /L_e^2=\pi^2 *210*10^3*22.88*10^3/380^2 =328403.568 \text{ kN}$$



❖ **Literature Review:**

The idea of 360 degree wheel rotation load carry vehicle isanalyzed from:

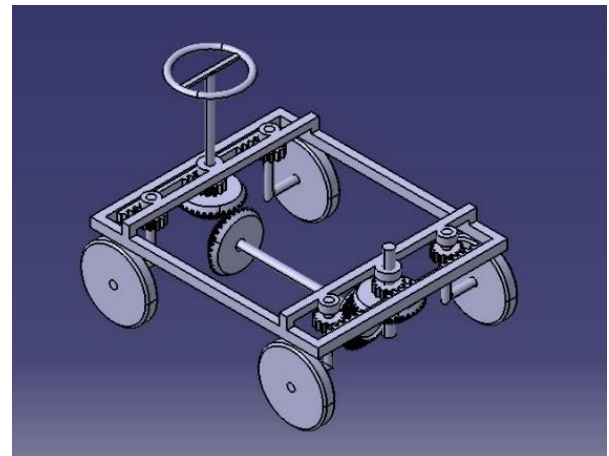
- LechKnapb, ZbigniewZebrowskib [1], presented a 360 degree rotating car to overcome the problem of parking space. This car has zero degree turning radius of a vehicle implies the vehicle rotating about an axis passing through the center of gravity of vehicle i.e. the vehicle turning at the same place, where it is standing. No extra space is required to turn the vehicle. So vehicle is to be turned in the space equal to the length of the vehicle itself. In this presentation, so got idea of 360 degree wheel rotation vehicle and have plane to make 360 degree wheel rotation load carry vehicle, this vehicle is to be used in different area like industries, hospital, railway platform, etc.

- Prof. Avhad N.V. and Prof. Bhane A.B. [2], presented a 360 degree rotating vehicle to overcome the problem of parking space. This project is about design of 360 degree rotating car to move in all direction. This design provides better comfort and also saves the time of customers, that's why it is also the reliable for the customer. As it is also battery operated car thus no fuel is required. Hence it is economical to the environment. This also reduces the cost of the car, and also got idea to use battery to operate this vehicle.
- Dilip Choudhari, et al. [3], presented a four wheel steering system for a car. 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 with the use of DC motor to turn left and right. In this presentation, the use of DC motor is to rotate the wheels 90 degree left and 90 degree right from original position.
- Er. Amitesh Kumar, et al. [4], presented zero turn four wheel steering system, the various functions of the steering wheel are, to control the angular motion the wheels, direction of motion of the vehicle, to provide directional stability of the vehicle while going straight ahead, to facilitate straight ahead condition of the vehicle after completing a turn, the road irregularities must be damped to the maximum possible extent. This project the use of steering is to rotate front wheels.

❖ **WORKING:** 90 degree steering mechanism basically helps to reduce the space required for a person to steer his vehicle. Our project of Fabrication of modified steering and drive mechanism for turning wheels through 90 degree in parallel parking, is a combination of four wheels steering for

90° turning. 90° steering mechanism is especially designed to decrease turning radius for parking purposes in confined spaces. For our project we are using rack and pinions, battery, bevel gears and other essential linkages.

- **Steering mechanism :** For steering of our vehicle we are using a special set of rack and pinions joined with two sets of steering arms L1, L2, L3 and L4 attached to the wheels on each sides of vehicle i.e. front and rear side. For steering of the vehicle, the steering wheel will be connected through a steering shaft to steering bevel gears DS, and the shaft from DS will connect the two pinions P1 and P2. When steering wheel is rotated in clock wise direction, the motion is transferred to the front pinion shaft which rotates pinion in clock wise direction due to which rack will slide towards left side and wheels will turn towards right side. Now the thickness of the pinions are sufficient to compensate the forward movement of rack.
- **Catia model:-**
 - parallel parking (90° steering) steering system on the rear side is engaged through the bevel



gear thus steering control will get transferred to all the four wheels of the vehicle to turn the vehicle at 90°. During this operation when steering wheel will move in anti-clock wise direction it will result in anti-clockwise rotation

nof front pinion shaft and clock wise rotation pinion shaft due to which front rack will move towards rightward and rear rack towards leftward and wheels will be steered through 90° . Now with the help of parallel drive mode which can be enabled by engaging the power can be transmitted to front wheels along with the rear wheels and vehicle can be parked either left or right side as per requirement.



❖ ADVANTAGES:

- It improves cornering stability.
- High speed straight line stability.
- Smaller turning radius improves steering efficiency.
- Comfortness is increases from driver point of view.
- Improved the traction and handling ability.

❖ DISADVANTAGES:

- Require four motors.
- Only used in individual drive system.

❖ APPLICATION:-

- Electric vehicles
- Parallel parking
- GO kart (mini race car)

❖ **CONCLUSION:** The project carried out by us made an impressive task in the field of automobile industries. It is very useful for driver while driving the vehicle. This project has also reduced

the cost involved in the concern. Project has been designed to perform the entire requirement task, which has also been provided.

The purpose of developing this project is to avoid parking problem, minimize the space between two parked cars to minimize the time required for parking reduces the problem of accidents during parking and to improve the design of existing vehicles.

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