PROTOTYPE OF 90 DEGREE STEERING MECHANISM

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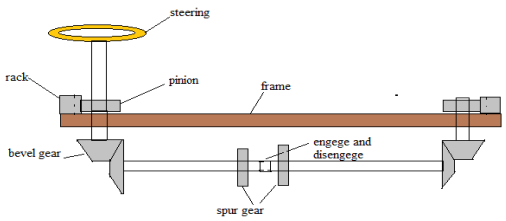
Abstract*: In this paper an effort is made on the development of 90 degree steering mechanism which will turn the wheels by 90 degrees. The proposed approach is to construct a vehicle whose wheels can turn 90 degrees by using an additional rack and pinion type steering mechanism for the rear wheels in addition with front wheels. Rear wheel steering mechanism will come into action at the time of parallel parking and can be engaged and disengaged with the help of lever which operates the engagement and disengagement of gears.

The main aim of our project is to design and develop 90 degree steering mechanism. The advantage of this system is that it requires limited space and it requires less time to park the vehicle than other.

Keywords* : *Parallel Parking , Frame, Bevel Gear, Spur Gear, Wheels, 90 Degree.

I. INTRODUCTION

Nowadays it is very hard to find a parking slot in metropolitan cities, hardly there is parking space for cars. If someone finds any space to park, the driver would have to move the car to and fro. If the driver is experienced then he/she would park the car without accident. If the car can perform parallel parking with itself it would be very easier to the drivers who are not good at parallel parking. This 90 degree steering mechanism can be implemented in vehicles. The objective of our work is better parking in minimum space available, saving time, zero turning radius. We have used a rack and pinion arrangement at the front and rear side of the vehicle. The steering mechanism used is Ackermann steering mechanism. When we park the car, we would just push the lever to engage the front and rear shaft. The arrangement is made such that when the steering is rotated then not only front wheels would rotate, the rear wheels will also rotate. This will make the car to move sideways.



II. COMPONENTS USED

1. Rack and Pinion
2. Roller Pinion
3. Bevel Gear
4. Wheels
5. Shaft
6. Spur Gear
7. Steering Wheels

III. BASIC TERMINOLOGY

1. Rack and Pinion

The rack is a bar containing teeth on one face for meshing with gear. The basic rack form is the profile of the gear of infinite diameter. Racks with machined ends can be joined together to make any desired length. The basic rack and pinion mechanism is used in steering system for the purpose to move the wheels either right or left while turning. The pinion revolve linearly over the rack which gives it infinite turning radius.

Features: Changes rotary motion into a rectilinear motion.

Application: A transfer system for machine tools, printing press, robots, etc.

Figure: Rack and Pinion

2. Bevel gear

Bevel gears are used to transmit power between two intersecting shaft. There are two common types of bevel gears straight and spiral. The elements of the teeth of the straight bevel gears are straight lines which converge into a common apex point. The elements of the teeth of the spiral bevel gears are spiral curves, which also converge into a common apex point involute profile is used for the form of the teeth for both type of gears. Straight bevel gears are easy to design and manufacture and give reasonably good service when properly mounted on shafts. However, they create noise at high speed

conditions. Spiral bevel gears, on the other hand, are difficult to design and costly to manufacture, for their required specialized and sophisticated machinery for their manufacture. Spiral bevel gears have smooth teeth engagement, which results in quiet operations, even at high speed. They have better strength and thus are used for high speed, high power transmission.

Figure: Bevel Gear

- Zerol gears are spiral bevel gears with zero spiral angle. This gears give more gradual contact and a slightly larger contact ratio.
- Hypoid gears are similar to spiral bevel gears that are mounted on shafts, which are non-parallel and non-intersecting. Hypoid gears are based upon pitch surfaces, which are hypoid of revolution. When two hyperboloids are rotated together, the resultant motion is a combination of rolling and sliding. The sliding is along the length of teeth and results in increased friction. Hypoid gears are used in automobile differentials. This gears allow the drive shafts to be placed well below the centre line of the rear axle and thereby lower the centre of gravity of the vehicle.

3. Wheels

Together with the tyre, a road wheel must support the weight of the vehicle and be capable of withstanding a number of side thrusts when cornering and torsional forces when driving. Road wheels must be strong, but light in weight. They must be cheap to produce, easy to clean, and simple to remove and refit.

Figure: Wheels

4. Shaft

The transmission shaft usually refers to the rotating machine element, circular in cross section, which supports transmission elements like gears, pulleys and sprockets and transmit power. The shaft is always stepped with max. Diameter in the middle portion and minimum diameter at the two ends, where bearings are mounted. The steps on the shafts provide shoulders for positioning transmission elements like gears, pulleys and bearings. Shafts are given specific names in typical applications, although all applications involve transmission of power, motion and torque. Transmission hafts are subjected to axial tensile force, bending moment or torsional moment or their combinations. Most of the transmission shafts are subjected to combined bending and torsional moment. The design of transmission shaft consist of determining the correct shaft diameter from strength and rigidity consideration.

5. Steering wheel

When the driver turns the steering wheel, the front wheels move and the car turns the corner! From the driver's point of view it is that simple, but many more things have to be taken into consideration. For example:

- the effect of road surface irregularities
- tyre behavior under cornering stresses
- an efficient mechanical system to give easy turning of the steering wheel
- driver feel must be maintained
- no (or very little) difference between empty and fully loaded
- the effect of accelerating or braking when the wheels are turned
- the front wheels should have a natural tendency to return to the straight ahead position.

Figure: Steering Wheel

IV. PROBLEM STATEMENT

Most of the cars use steering mechanism only for front two wheels of the vehicle. The steering mechanism used only for front two wheels increases the turning radius and it also increases the efforts of the driver while parking.

Due to the large turning radius it is difficult to park the vehicle in small areas. Thus to overcome this problem we have designed a steering system which will turn the wheels with zero turning radius.

Many of the city people are facing problems in traffic due to increasing vehicles and limited space for turning the vehicle so this steering mechanism will help in turning the vehicle easily within small space.

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V. CALCULATION

Frame: The Frame is the main supporting structure of a vehicle, to which all other components of vehicle are attached. The main function of frame in vehicle is to support the vehicle's mechanical components and body. It also deals with the static and dynamic loads. Here, the frame is made up of mild steel which is in rectangular shape. The length of the frame is 1220 x 760 mm.

Calculations

Area = 645016mm^2
Length = 1220mm
Breadth = 760mm

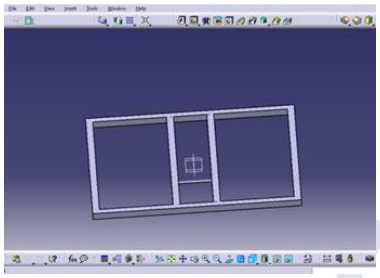


Figure: Frame

Rack and Pinion: The rack is a bar containing teeth on one face for meshing with gear. The basic rack form is the profile of the gear of infinite diameter. The rack and pinion is made up of carbon steel (C45).

Calculations

m = 2mm
Deddendum = 1.25*m = 2.5mm
Clearance = 0.25m = 0.5mm
Working depth = 2m = 4mm
Whole depth = 2.25m = 4.5mm
Tooth thickness = 1.5708*m = 3.1416mm
Tooth Space = 1.5708*m = 3.1416mm
Fillet radius = 0.4m = 0.8mm

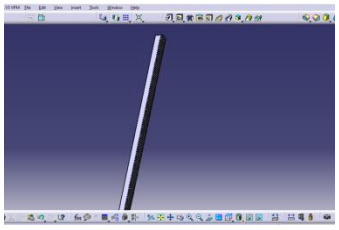


Figure: Rack

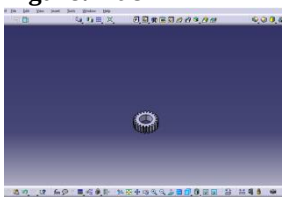


Figure: Pinion

Bevel Gear: Bevel gears are used to transmit power between two intersecting shaft. There are two common types of bevel gears straight and spiral. The elements of the teeth of the straight bevel gears are straight lines which converge into a common apex point. Here, we have used Straight Bevel gears. The Bevel gear is made up of Carbon steel (C45).The no. of teeth on pinion are 30 and that on gear are 15.

Calculations

m = 2mm
Zp = 30
Zg = 15
b = 5.6*m=5.6*2=11.2mm
dp = m*Zp = 2*30 = 60mm
dg = m*Zg = 2*15 = 30mm
A_o = 16.79*m = 16.79*2 = 33.58mm^2

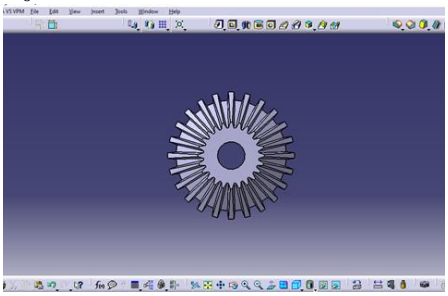


Figure: Bevel Gear

Spur Gear: In case of spur gears the teeth are cut parallel to the axis of the shaft, Spur gears are used only when the shafts are parallel.

Calculations

m = 1.5mm
Zp = 56
Zg = 56
b = 10*m = 10*1.5 = 15mm
dp = m*Zp = 1.5*56 = 84mm
dg = m*Zg = 1.5*56 = 84mm

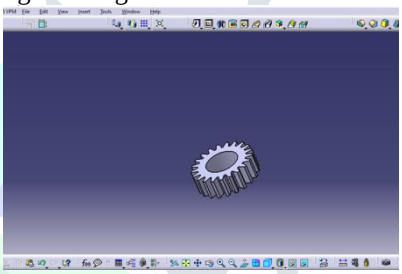


Figure: Spur Gear

Shaft: The transmission shaft usually refers to the rotating machine element, circular in cross section, which supports transmission elements like gears, pulleys and sprockets and transmit power. The design of transmission shaft consist of determining the correct shaft diameter from strength and rigidity consideration. The shaft is made up of Mild Steel. The length of shaft is 1120mm. Shaft transmits power from front to rear side.

Calculations

d = 15mm
Length = 1120mm

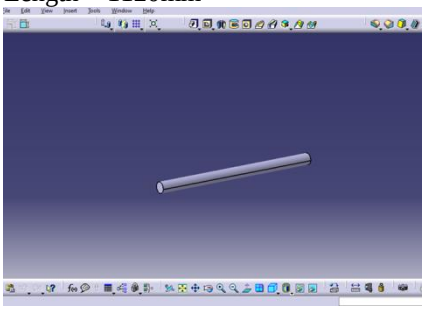


Figure : Shaft

VI. WORKING & ANALYSIS

In this model we are manually applying the power to the mechanism in order to turn the wheels 90 degree. Basically our project focuses on rear wheel turning mechanism at 90

degree, simultaneously with the front wheel at the time of parking. This causes the system to take zero turning radius which is efficient compared to normal working mechanism. This system is achieved by providing an additional rack and pinion mechanism at the rear end side of the system. Wheels are attached to both ends i.e. front and rear with rack which is placed on frame.

In normal working when there is no parking purpose, it will act as a normal Ackerman mechanism where power is transmitted to the steering, then to the mechanism and wheels, which is as similar to as a working of normal mechanism used in vehicles i.e. four wheelers. While parking purpose, a lever is provided for engagement and disengagement of front and rear rack and pinion mechanism, which is then used to rotate the wheels at 90 degree either on left or right side. Bevel gears are used at both the ends which provides the movement and rotation of shaft for front side and for rear side else for movement of wheels, when steering is moved/ rotated. At the centre, the two pairs of spur gears are used which acts as a reverted gear train.

The shafts are provided in between Bevel and spur gear at front as well as rear sides which are used to transmit power. When vehicle is supposed to be parked, the engagement of spur gears are made by the lever provided, which meshes the gear. As long as the lever is engaged, and the steering is moved it rotates the wheels , as the front shaft is rotated due to the engagement (reverted gear train mechanism) same amount of power is transmitted to the rear side which turns the wheels. As Bevel gear is placed at the rear end also, it is responsible for the movement of rack and eventually wheels are also turned

After parking, the lever is again pulled which disengages the spur gear and hence again normal rack and pinion is in use. So the approach is to construct a prototype whose wheel can turn 90 degree by using an additional rack and pinion mechanism system for rear wheel in addition to the front wheel. The rear wheel mechanism will come into action at the time of parking only.

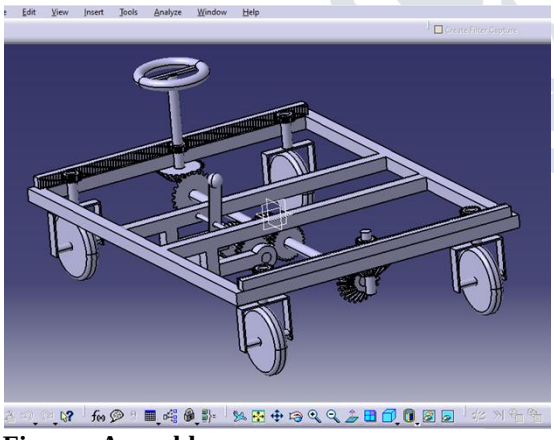
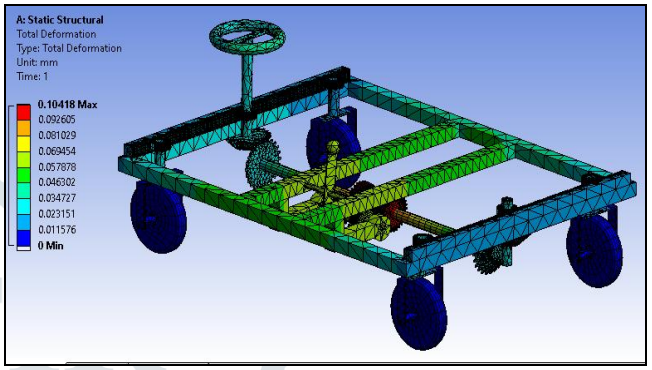


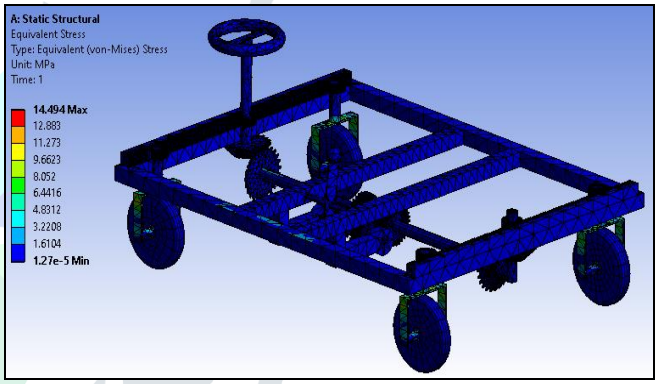
Figure : Assembly

I. ANALYSIS

Properties of Outline Row 3: Structural Steel

	A	B	C
1	Property	Value	Unit
2	Material Field Variables	Table	
3	Density	7850	kg m^-3
4	Isotropic Secant Coefficient of Thermal Expansion		
6	Isotropic Elasticity		
7	Derive from	Young's Modulus an...	
8	Young's Modulus	2E+11	Pa
9	Poisson's Ratio	0.3	
10	Bulk Modulus	1.6667E+11	Pa
11	Shear Modulus	7.6923E+10	Pa





VII. CONCLUSION

We know that most of the vehicles use rack and pinion mechanism only for front two wheels of the vehicle but by using additional rack and pinion for the rear wheels we can easily park the vehicle. From this project we can create a user friendly vehicle. Also the materials for the project can be easily manufactured or are available in the market.

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