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# DESIGN AND FABRICATION OF DUAL AXIS STEERING MECHANISM

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**Abstract.** Whether a car has front-wheel drive, rear-wheel drive, or all-wheel drive, the majority of current models use a two-wheel steering system to control their movement. However, four wheel steering vehicles are being employed more frequently as a result of increased safety awareness because they are also renowned for their outstanding performance and stability. They are wheels of conventional two-wheel steering vehicles do not assist with steering and simply follow the front wheels' route. In four-wheel steering, the wheels can be turned left or right depending on the situation. The direction of rotation for the rear wheels might be either parallel to the front or opposite. The four-wheel system is made to operate in three different ways. Specifically, rotations that are in-phase, out-of-phase, and zero.

*Keywords*—Design, fabrication, dual axis steering mechanism, review.

## 1. Introduction

These days, handling vehicles is increasingly challenging due to the growing amount of traffic on the roads. The current situation necessitates the investigation of novel vehicle handling systems, which in turn compels us to look for an alternative to the existing system or a modified steering system for improved handling. There isn't a driver out there who doesn't wish they could lessen their car's turning radius or slide the entire vehicle sideways without turning it when it enters a crowded or constrained space. Here, the Four Wheel Three Mode programme accomplishes the same by manipulating the rear wheels as well, per our needs.

Contrast it with four-wheel drive, in which a vehicle's four wheels are each given power. When necessary, this technology also enables the rear wheels to be turned in relation to the direction of the front wheels. As a result, the car is easier to control, especially when turning, parking, or entering a crowded or small space. This technology is mostly used in off-road vehicles including forklifts, construction and agricultural machinery, and mining equipment.

It is helpful in passenger vehicles as well, primarily SUVs. In-phase steering occurs when the front and rear wheels are both turning in the same direction, and this causes the car to drift somewhat sideways. On various sorts of vehicles, other configurations are occasionally found, such as rear-wheel steering or a tiller. Tanks and other tracked vehicles frequently use differential steering, in which the tracks are designed to move at different speeds or even in the opposite direction from one another to vary the direction of travel.

### 2.1 NEED FOR FOUR WHEEL STEERING

- To minimize the over steering & under steering Effects.
- To turn short corners effectively.
- To reduce turning radius.

### 2.2 BASIC GEOMETRY

Curves that a traditional car's rear wheels describe. The car's inner and outer rear wheels do not travel at the same pace as the vehicle as a whole. Making sure the wheels are pointed in the right directions is the basic goal of steering. Usually, a number of links, rods, pivots, and gears are used to accomplish this. Caster angle is one of the key ideas; each wheel is guided using a pivot point in front of the wheel, which causes the steering to naturally centre itself in the direction of motion.

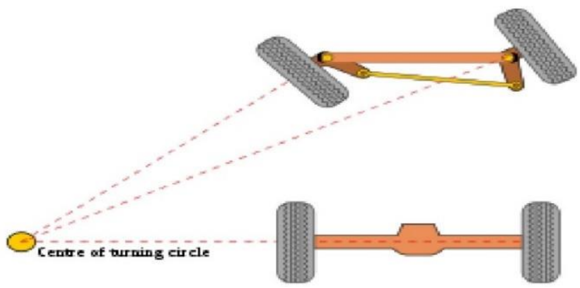


Fig 1 Ackermann steering geometry

To take into consideration the fact that the steering linkages between the steering box and the wheels typically comply to a version of Ackermann steering geometry that the degree of toe appropriate for driving straight lines is inappropriate for turns since the inner wheel actually travels a path with a smaller radius than the outer wheel during a turn. Together with the tyres, the wheels' angle with the vertical plane affects steering dynamics (see camber angle).

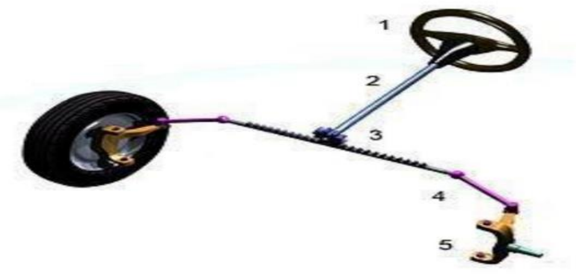


Fig 2 Rack and pinion steering mechanism

Rack and pinion steering mechanism:
1 Steering wheel
2 Steering column
3 Rack and pinion
4 Tie rod
5 Kingpin

**2.3 RACK AND PINION**

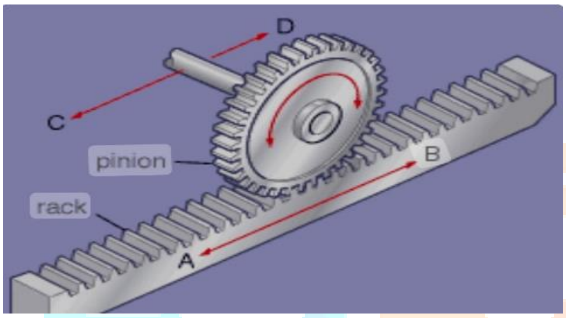


Fig 3 Rack and pinion

The steering wheel of an Ariel Atom sports vehicle is equipped with a rack and pinion device. For the vast majority of large volume production, this is often installed on the opposite side of this panel.

**2.4 STEERING BOX**

Fig 4 Steering box

Classical (non-assisted) steering box of a car, you might note that the system enables you to modify the braking and steering systems, you May also observe the frame's mounting system.

**2.5 POWER STEERING**

A vehicle's power steering aids the driver in steering by using some of the vehicle's power to help turn the steering wheels around their axes. As the effort required to turn the wheels about their steering axis has increased, frequently to the point where it is difficult to turn the wheels. This is especially true as vehicles have gotten heavier and switched to front-wheel drive, especially when using negative offset geometry. where significant muscular effort would be required without electrical aid. Automakers have created power steering systems, or more accurately power-assisted steering, to address this issue. Road-going vehicles must have a mechanical linkage as a failsafe. Power steering systems come in two flavours: hydraulic and electric/electronic. A hybrid hydraulic-electric system is also conceivable.

**2.6 SPEED SENSITIVE STEERING**

Speed sensitive steering, which strongly assists the steering at low speeds and softly assists the steering at high speeds, is a development of power steering. The car manufacturers believe that while manoeuvring for parking, but not when moving quickly, drivers may need to make strong steering inputs. The Citroen SM with its Diravi layout was the first vehicle to have this feature, but instead of adjusting the amount of assistance like modern power steering systems, it changed the pressure on a centring cam, which caused the steering wheel to attempt to "spring" back to the straight-ahead position. Current speed-sensitive power steering systems give a more direct sensation by reducing the mechanical or electrical assistance as the vehicle speed rises. This trait is increasingly becoming more prevalent.

**2.7 FOUR-WHEEL STEERING**

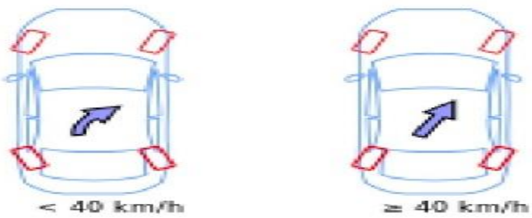


Fig 5 Speed-dependent four-wheel steering

Certain automobiles use a technology called four-wheel steering (sometimes known as all-wheel steering) to boost vehicle stability when manoeuvring and improve steering reaction. Reducing turning radius at low speed or increasing it at high speed.

a) ACTIVE FOUR-WHEEL STEERING

When the driver steers, an active four-wheel steering system, all four wheels turn simultaneously. The rear wheels are used for steering most active four-wheel systems. An actuator and a computer control the wheels. Generally speaking, the rear wheels are unable to turn as far as the front wheels. Rear steer controls and choices to steer the rear wheel independently of the front wheels are available. When moving slowly (such as when parking), the rear wheels turn in the opposite direction from the front wheels, cutting down on the turning radius by up to 25%, which can be crucial for large trucks, tractors, and vehicles pulling trailers. When moving quickly, however, both the front and rear wheels turn in unison (electronic control), allowing the vehicle to change position quickly.such that the vehicle's straight-line stability is improved and position changes can be made with minimal yaw. The "Snaking effect" felt throughout so, driving on highways while pulling a travel trailer is largely eliminated.

**2.8 PASSIVE REAR WHEEL STEERING**

Passive rear steering is a common feature of modern cars. While cornering, the rear wheels of many cars have a tendency to drift slightly to the outside of the turn, which can lessen the stability. The passive steering system counteracts this tendency by guiding the wheels just a little to the inside of the corner using the lateral forces produced during a turn (due to suspension geometry) and the bushings. As a result, the car is more stable during turns. Compliance understeer, or its reverse, is the impact that all suspensions have. Using a Watt's Link on a live rear axle or toe control bushings on a twist beam suspension are typical techniques for achieving compliant understeer. On a rear independent suspension, it typically It is often accomplished on an independent rear suspension by altering the rates of the rubber bushings in the suspension. Certain suspensions, such those with Hotchkiss live axles or an IRS with a semi-trailing arm, have compliance over steer as a result of geometry, although this can be reduced by changing the pivot points of the leaf spring or trailing arm. The idea of passive rear wheel steering is not new; it has been in use for a long time, but it is not necessarily acknowledged as such.

## 2.9 REAR WHEEL STEERING

Certain vehicle types, including forklift trucks, camera dollies, and early pay trucks, exclusively have rear wheel steering loaders, the Dymaxion automobile designed by Buckminster Fuller, and the Thrust SSC. The reason why rear wheel steering is frequently unsteady is turning causes a change in the steering geometry, which reduces the turn radius (oversteer) rather than increasing it (understeer).

## 3.1 PRINCIPLE OF WORKING

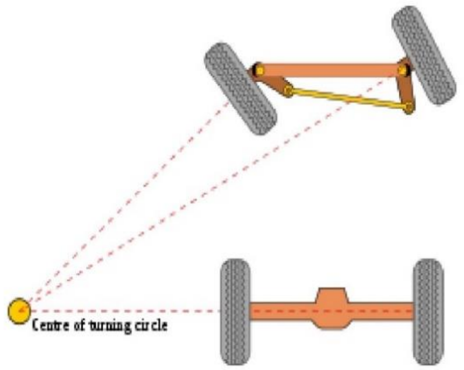


Fig 6 front and rear wheel steer in same direction

A steering arrangement, spur gears, bevel gears, and lock nut make up our project. Front wheel steer is one of the three modes. The steering function resumes in normal state when the lock nut has been released. Only the front wheels are steering. The lock nut, however, when it is inserted, the Other two modes are available. The spur gears engage when the gear arrangement is moved to one position, ensuring that the rear wheels are steering in the same direction as the front wheels. The spur gear disengages and the bevel gear engages when the gear arrangement is shifted to the opposite side. The rear wheel steers In the opposite direction from the front wheel because of the bevel gear configuration. Third mode steering is the effect of this.

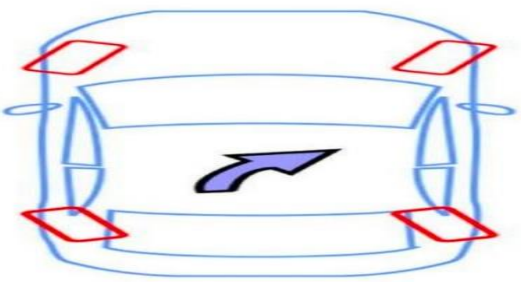

Fig 7 Both wheels in opposite direction

### 3.1.1 FRONT WHEEL STEERING

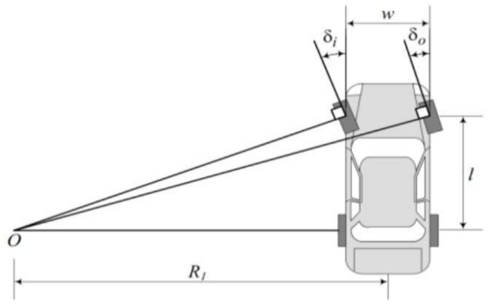


Fig 8 A front wheel steering vehicle and the ackerman condition

When a front-wheel-steering 4WS vehicle turns to the left while travelling very slowly, there is a kinematic between the inner and outer wheels that permits them to turn without slipping. The expression for the condition, known as the Ackerman condition, is $\cot\delta_0 - \cot\delta_i = w/l$.............. (1)
Where δi is the steer angle of the inner wheel and 0 is the steer angle of the outer wheel. Based on the turning centre O.

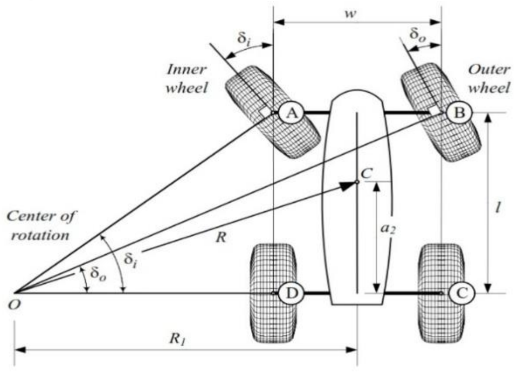


Fig 9 A front wheel steering wheel and steer angles of the inner and outer wheels

The inner and outer wheels are identified. The track, denoted by w, is the separation between the steer axis of the steerable wheels. The separation between the front and actual axles is referred to as the Wheelbase.
The vehicle's track w and wheelbase l are regarded as its kinematic width and length. A directed vehicle's mass centre will rotate in a circle with radius R,

$R = a_2^2 + l^2 \cot^2 \delta$)............................(2)

Where is the cot-average of the inner and outer steer angles, we get

$\cot\delta = (\cot\delta_o + \cot\delta_i)/2$ ..........................(3)

The angle δ represents the steer angle of an analogous bicycle with the same wheelbase l and radius R.
Proof. The normal line to the centre of each tire's plane must connect at a single location in order for all wheels to turn freely on a curved road. The Ackerman condition is as follows. Hence, the inner wheels are on the left and the turning centre O is there are located nearer to the centre of rotation than the left wheels. The triangles OAD and OBC can be used to compute the inner and outer steer angles, respectively, as follows:

$\tan\delta_i = l/(R_2-(w/2))$..............(4)

$\tan\delta_o = l/(R_1+(w/2))$..............(5)

Eliminating R1

R1 =(1/2*w)+(l/tan δi )=(1/2*w)+(l/tan δo )...............(6)

The Ackerman condition(1), which is a, is provided by there is a direct connection between δi and δo.

cot δo −cot δi = w/l ............(7)

We develop an equivalent bicycle model to determine the vehicle's turning radius R. At the mass centre C, the radius of rotation R is parallel to the vehicle's velocity vector v. Applying the bicycle model's geometry, we obtain

R2 = a22 + R12. ………………..(8)

cotδ = Ri/l

=1/2(cot δi + cot δo) ..................(9)

and therefore,

R = (a22 + l2 cot2 δ).......................(10)

When the vehicle is moving at a too-low speed and the slip angles are zero, the Ackerman condition is required. There is no centrifugal or lateral force to they counterbalance one another. Because it is a static condition with zero motion, the Ackerman steering condition is also known as the kinematic steering condition. Ackerman steering, Ackerman mechanism, or Ackerman geometry are terms used to describe a device that delivers steering in accordance with the Ackerman condition (1). There isn't a four-bar linkage steering system that can properly satisfy the Ackerman criterion. However, we might create a multi-bar connection that works reasonably well and is accurate at a few angles. The figures show the Ackerman condition for various w/l values. Angles of inner and outer steering reduce w/l to get closer to one another.

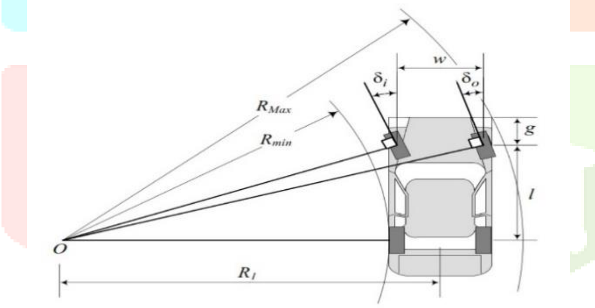

Fig 10 The required space for a turning two axle vehicle

### 3.1.2 FOUR WHEEL STEERING

The kinematic steering condition, which requires that the perpendicular lines to each wheel meet at one point, must be used at very low speeds. The point of intersection is the turning the vehicle's centre. A vehicle with negative four-wheel steering, while this shows a vehicle with positive four-wheel steering. In a favourable 4WS scenario, the In a positive 4WS situation, the front and rear wheels steer in the same way, and they steer in the opposite direction in a negative 4WS situation. A 4WS vehicle's steer angles must satisfy the kinematic condition

cot δof − cot δif =(wf/l) −(wf/l )*(cot δof -cot δif )/(cot δor −cot δir)...............(11)

Where the front and rear tracks, the inner and outer steer angles of the front wheels, and the rear steer angles are, respectively, ir and or l is the vehicle's wheelbase, and there are inner and outer wheels. The following equation, which is more broad, can also be used to describe the relationship between a 4WS vehicle's steer angles.

cot δfr −cot δfl = wf/l −wr/l *(cot δfr−cot δfl )/cot δrr −cot δrl..................(12).

Where the steer angles for the front left and right wheels are δfl and δfr, and the steer angles for the rear left and right wheels are δrl and δrr. If we presents the kinematic condition for both positive and negative 4WSsystems after the steer angles are defined in accordance with the sign convention indicated. The steer angle is the angle between the vehicle's x-axis and the wheel's xw-axis, measured about the z-axis, using the wheel coordinate frame (xw, yw, zw). Hence, when the wheel is rotated to the left or right, the steer angle is positive, and when it is turned to the right, it is negative. Proof. For a 4WS's wheels to be slip-free in a turn, they must at a common location, the normal lines to the centres of each tire-plane converge. The kinematic steering situation is as follows. Figure depicts a 4WS vehicle making a left turn. The inner wheels are the left wheels closest to the turning centre (O), which are on the left. The separation along a line between two points in a coordinate system. The triangles OAE and OBF can be used to determine the inner and outer steer angles for the front, while the triangles ODG and OCH can be used to compute the inner and outer steer angles for the back. O and the car's axles are denoted by the body measurements c1, and c2.

tan δif =c1/ R1 −wf /2.................(12)

tan δof =c1 /R1 +wf /2................(13)

tan δir =c2 /R1 −wr /2.................(14)

tan δor =c2 /R1 +wr /2................(15)

Eliminating R1

R1 =1/2*wf +c1 /tan δif.............(16)

= −1/2*wf +c1 tan δof..............(17)

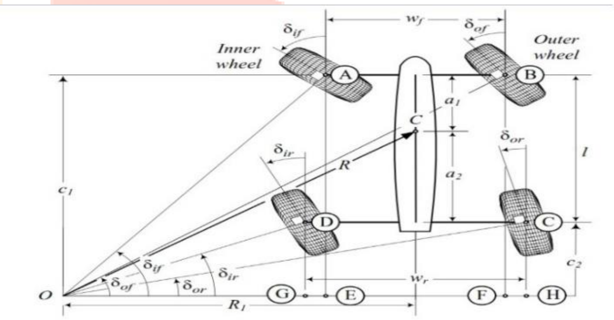


Fig 11 Illustration of a negative four wheel

## 3.2 WORKING PRINCIPLE OF THREE MODE STEERING

### 3.2.1 FRONT-WHEEL-STEERING VEHICLE

The steering function resumes in normal state when the lock nut has been released. Only the front wheels are steering. The first mode operation

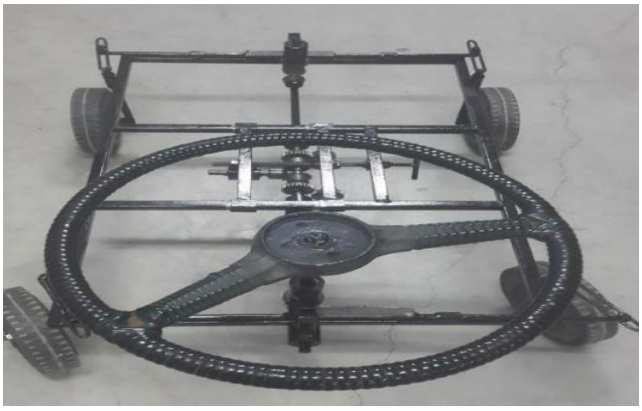

Fig 12 Front wheel steering vehicle

### 3.2.2 NEGATIVE FOUR-WHEEL STEERING

The other two modes are usable in mode operating when the lock nut is inserted. The bevel changes when the gear arrangement is moved into one position. Gears are engaged, ensuring that the rear wheels are steering in the same direction as the front wheels. The second mode's operation

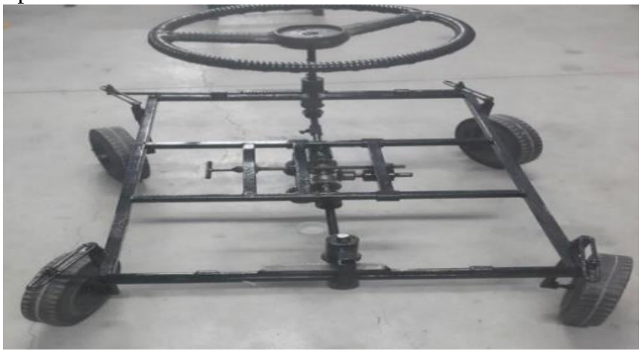

Fig 13 Negative four wheel steering

### 3.2.3 POSITIVE FOUR-WHEEL STEERING

The bevel gear engages and disengages when the gear arrangement is moved to the opposite side. The rear wheel's spur gear arrangement causes this. Opposes the direction of the front wheel during turning. Third mode steering is the effect of this. There are three steering modes that may be switched between as needed, which helps with parking in busy locations, navigating tight spaces, and driving off-road.

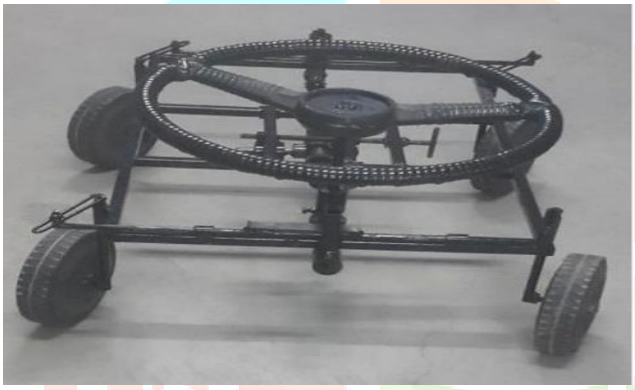

Fig 14 Positive four wheel steering

### 3.3 DESIGN OF THE STEERING SYSTEM

TOP VIEW

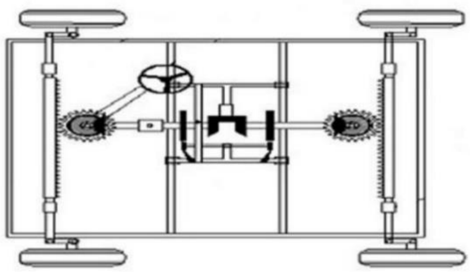

Fig 15 Top view

SIDE VIEW

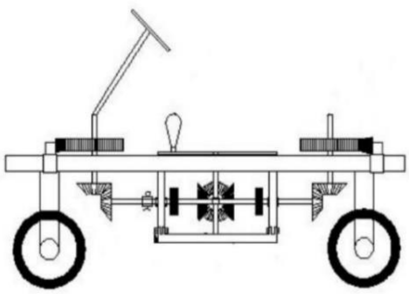

Fig 16 Side view

### 4.1 LIST OF MATERIALS

To fully meet the needs of the machine's full operation, the four wheel steering with three mode operation comprises of the following parts.

- Rack and pinion
- Bevel gear
- spur gear
- Steering
- Wheel
- Hinge joint

### 4.2 FACTORS RUNNING INTO THE MATERIAL SELECTION

The following discussion covers the numerous elements that influence material selection.

### 4.2.1. PROPERTIES

The chosen material must have the qualities required for the intended use. The numerous specifications that must be met can include weight, surface, and Finish, rigidity, resistance to chemical attacks on the environment, service life, dependability, etc.

The four types of primary material characteristics listed below have a significant impact on the choice of materials.

- Physical
- Mechanical
- From manufacturing point of view
- Chemical

Melting point, thermal conductivity, specific heat, coefficient of thermal expansion, and specific gravity are some of the physical characteristics that are involved. Magnetism, electrical conductivity, etc. Strength in tensile, compressive shear, bending, torsion, and buckling loads, fatigue resistance, impact resistance, elastic limit, endurance limit, and modulus of elasticity, as well as hardness, wear resistance, and sliding properties, are among the various mechanical properties that are concerned.

### 4.2.2. MANUFACTURING CASE

The need for the best surface attributes or lowest manufacturing costs that can be achieved via the use of suitable coating materials may require the usage of unique materials.

### 4.2.3. QUALITY REQUIRED

In most cases, this has an impact on the production procedure and ultimately, the material. For instance, it would never be advisable to go casting with fewer people. Components that can be produced from steel much more cheaply through welding or hand forging.

### 4.2.4. AVAILABILITY OF MATERIAL

There could be a shortage or scarcity of some resources. The designer will therefore be forced to utilise another material, even if it may not be ideal. Alternative for the intended substance. Moreover, keep in mind when the product will be delivered and when the materials will be delivered.

## 5.1 CALCULATION

### 5.1.1 CALCULATING ACKERMAN ARM ANGLE

Weight distribution = 60:40(front : rear)
Wheel base (L) = 2.669m
Track width (tw) =1.524m

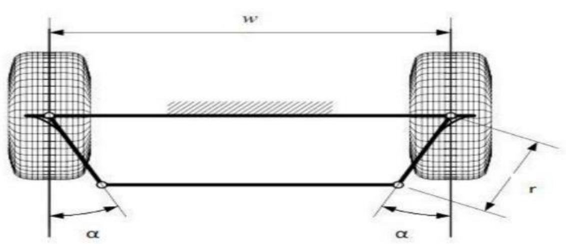


Fig 17 A trapezoidal steering mechanism

tan-1[(kingpin center to center distance/2)/wheelbase]= α
tan-1[(51/2)/105.2]= 13.640
Therefore,
Ackerman Arm Angle (α) = 13.64°
Determining the Arm Base and Tie Rod Length We may divide the trapezoid ABCD into a rectangle and two triangles to determine the length of the tie rod. Remember that the ratio between the side opposing the angle and the hypotenuse is the SIN of an angle.
In shorthand it looks as follows:
Sin 13.640=Y/R
Where, Ackerman Arm Radius R = 6" (Assumption)
Arm base(Y)=6*sin13.640=1.4149
Arm Base (Y) = 1.41490
As a result, the computed value for Arm Base (Y) is 1.4140 inches shorter on top than the kingpin centre to centre distance.
LT = DKC -2RAA[sin(Ackerman Angle)]
Where:
LT = length of the tie rod
DKC = distance between Kingpin's center to center
RAA = radius of the Ackerman Arm (Assumed) = 6
LT= 51-2*6(sin13.640)= 48.170
Length of Tie Rod = 48.17 in

### 5.1.2 TURNING CIRCLE RADIUS

We used theoretical calculations to determine the turning circle radius before confirming the wheel radius of each individual wheel and the car's turning circle radius. By our draught,
we calculate the inside lock angle of the front wheels (θif).
By Ackerman Mechanism,
Sin(α + δ if ) =Y+X/R
Where, α = Ackerman Angle
δ if = Inside Lock Angle
Y = Arm Base
X = Linear Displacement of rack for one rotation of Pinion
R = Ackerman Arm Radius
Sin (13.640 + δ if ) = 1.415+3.1/6
δ if =35.160
Thus, the calculation of the centre of gravity with regard to the rear axle yields the inside lock angle of the front wheel.
We know that
R2=a2+R12……………………………….(1)
Where, R = 5.394 m (Turning radius of the vehicle)
A2 = Distance of CG from rear axle
R1 = Distance between instantaneous centre and the axis of the vehicle
To find a2
Wf = W*a2/L……………………….(2)
Where, Wf = Load on front axle (On basis weight distribution)
W = Total weight of car
L = Wheelbase
Therefore,
A2=1.60m
Substituting the value of a2 in the above equation
R1=5.15m
To find position of instantaneous Center from both the axis
From our standard calculations of 2 Wheel Steering,
δ if = 35.160
tan δ if = c1 /R1 – tw/2…………………………….(3)
Where, tw = Front track width
δ if = Inside Lock angle of front wheel
Therefore,
tan 35.160 = C1 / 5.15*0.762
C1 = 3.09m
C1 + C2 = R ……..……………………….. (4)
Where, C1 = Distance of instantaneous centre from front axle axis
C2 = Distance of instantaneous centre from rear axle axis
Therefore, C2 = 5.394 – 3.09 C2 = 2.304m
Therefore, from equation (3) and (4)
C1 = 3.09m C2 = 2.304m
To find the remaining lock angles
to find δ of = outer angles of front wheel
tan δ of =[C1/(R1+tw/2)]……….(5)
tan δ of=3.09/(5.15+0.762)
δ of=tan-7[3.09/(5.15+0.762)]
δ of=27.590
to find δ ir = inner angles of rear wheel
tan δ ir =[C1/(R1-tw/2)]……….(6)
tan δ ir =2.304/(5.15+0.762)
δ ir =tan-1[2.304/(5.15+0.762)]
δ ir =27.700
to find δ or = outer angle of rear wheel
tan δ or =[C2/(R1+tw/2)]……….(7)
tan δ or =3.09/(5.15+0.762)
δ or =tan-1[2.304/(5.15+0.762)]
δ or =21.290
We now minimise the vehicle's turning radius while maintaining the wheelbase and track width by taking the same steering angles for the front and back tyres. Identical to the benchmark car.
Calculations for the turning circle with the same steering angle to find turning radius, R
R2=a22+L2(cot2δ)……………………………….(8)
Where, δ = Total steering angle of the vehicle To Find δ
Cotδ=(cot δ +cot δ) /2…………………………………….(9)
Where, δi= total inner angle of the vehicle δo = total Outer angle of the vehicle Therefore,
Cotδ= (cot(35.160+27.700) + cot (27.590+21.290))/2
Therefore, substituting the above values in equation (8)
We put this above value of R in equation (1), to get the new value of R1, i.e.
R2= a2+R12
R1 = 1.84m (For the new value of R) Considering the turning radius as 2.44m, Further calculation for C1 and C2 from equation (3) and (4)
tan δ if = C1/(R1-( tw/2))
C1+C2=R
The inside and outside lock angles of the front and rear wheels are thus as follows when taking into account the new values of C1 and C2. Hence, substituting the updated values of C1 and C2 in equations (3), (5), (6), and (7) are as follows to obtain the inside and outside angles' final values:
tan δ if = C1/(R1-tw/2)
tan δ of = [C1/R1+tw/2)]
tanδ if = [C2/R1-tw/2)]
tan δ or = [C2/R1+tw/2)]
δ if=35.160(inside lock angle of front wheel)
δ of=16.980(outside lock angle of front wheel)

$\delta_{ir}$=57.320(inside lock angle of rear wheel)
$\delta_{or}$=32.860(outside lock angle of rear wheel)
therefore,
$\delta = \delta_{if} + \delta_{ir}$(total inner angle of the vehicle)
$\delta$ =35.160+57.320=92.480
$\delta = \delta_{of} + \delta_{or}$(total outer angle of the vehicle)
$\delta$ =16.980+32.860=49.480
We determine the following numbers for the Radius of All Wheels from our draught: Inner front wheel radius (Rif) = 1.426 metres Front outer wheel radius (Rof) =2.813m Inner rear wheel (Rir) radius: 2.185 metres (Ror) = 3.264m Radius of outer rear wheel the Turning Circle Radius of our vehicle is decreased to 1.84m when compared to our benchmark vehicle's (Honda Civic) Ackerman Steering Mechanism after we took the aforementioned figures into consideration. Therefore,
Cot$\delta$=(cot92.480+cot49.840)/2
Cot$\delta$=0.400
Therefore, substituting the above value in equation (8)
The Turning circle radius of whole car=1.92

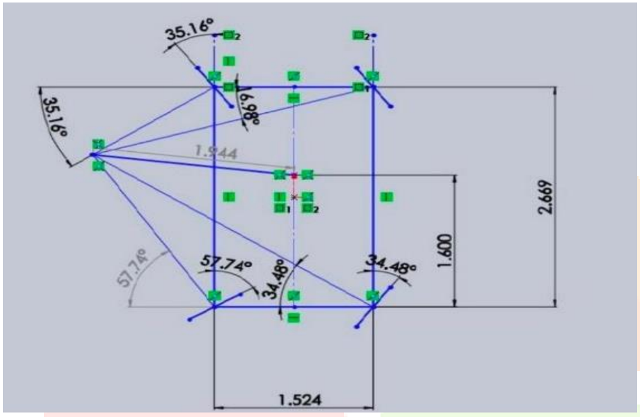


Fig 18 Turning circle radius drafted

As a result, the number we determined agrees with the value seen in the SOLIDWORKS draught of the Ackerman Steering Mechanism. Hence verified as a result, the car's original turning circle radius, which was 5.394 metres, has been lowered to 1.92 metres, a 64.4% overall reduction.
How to Calculate the Steering Ratio
Formula for calculating steering ratio of a vehicle:
R=s/
Where R = radius of curvature (same as units of wheelbase) = 1.92m = 75.59"
S = wheelbase = 105.1"
A = steering wheel angle = 3600 (assumed for one rotation of steering wheel)
N = steering ratio
So, our car's steering ratio is 8.177:1, meaning that for every 8.177 degrees the steering wheel turns, the tyre turns by an angle of one degree. In light of the aforementioned value, According to the steering ratio, turning the car requires less effort from the driver, which results in considerably greater control and manoeuvrability.

## 6.1 CONCLUSION

We have had a great opportunity to put our limited knowledge to use through this project work. While working on this project, we learned a lot about planning, buying, assembling, and machining from a practical standpoint. We consider the project effort to be an excellent way to open doors between institutions and industries. We are pleased with the effective completion of the task in the allotted period. Working satisfactorily are the FOUR WHEEL THREE MODE STEERING SYSTEM. We are able to comprehend the challenges of sustaining quality and tolerances. Making the most of the facilities at our disposal, we did our best. Let's add a few more paragraphs on our project work's impressions in the closing remarks.
As a result, we created the "FOUR WHEEL THREE MODE STEERING SYSTEM" to help with low cost automation. The use of pneumatics results in a smooth operation. They can be improved and enhanced in accordance with the applications by utilising more strategies.

## 7.1 FUTURE PROSPECT OF THE PROJECT

We have looked at how 4WS affects the vehicle's stability and the driver's manoeuvrability, and now we are going to look at what the future holds for us. The vehicle with uncompressed static stability, front and rear tracking, vehicular stability at high speed lane changing, a smaller turning radius, and improved parking assistance will be developed as a result of the successful implementation of 4 Wheel Steering using mechanical linkages & a single actuator. The system described below can also be used to implement a wide range of automobiles, typically from hatchbacks to trucks, and is not restricted to the benchmark used in this project. One of the most affordable steering systems for increased agility and driver convenience is provided by this together with overhead costs One of the most affordable steering systems for enhanced manoeuvrability and driver accessibility. This technology will become even more manoeuvrable and user-friendly when concepts like "ZERO TURN" driving, which is used in Tata Pixel vehicles, and "360o Turning," which is used in Jeep Hurricane vehicles, are implemented.

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