UNIT - VI

Functions of steering

- **Primary function** of steering is to achieve angular motion of the front wheels.
- This is done through linkage and steering gear which converts the rotary motion of the steering wheel into angular motion of the front road wheels.
- **Other functions are :**
- To provide directional stability of the vehicle when going straight.
- To provide perfect rolling motion of the road wheels all the times.

- To facilitate straight ahead recovery after completing a turn.
- To minimize tyre wear.

Requirements of steering

- Steering mechanism should be very accurate and easy to handle.
- The effort required to steer should be minimal and must not be tiresome to the driver.
- Steering mechanism should also provide directional stability.

Wheel Alignment

- Positioning of the steered wheels to achieve the following is termed as wheel alignment.

1. To achieve directional stability during straight ahead position.
2. To achieve perfect rolling on steering.
3. To achieve recovery after completing the turn.

Factors of Wheel Alignment

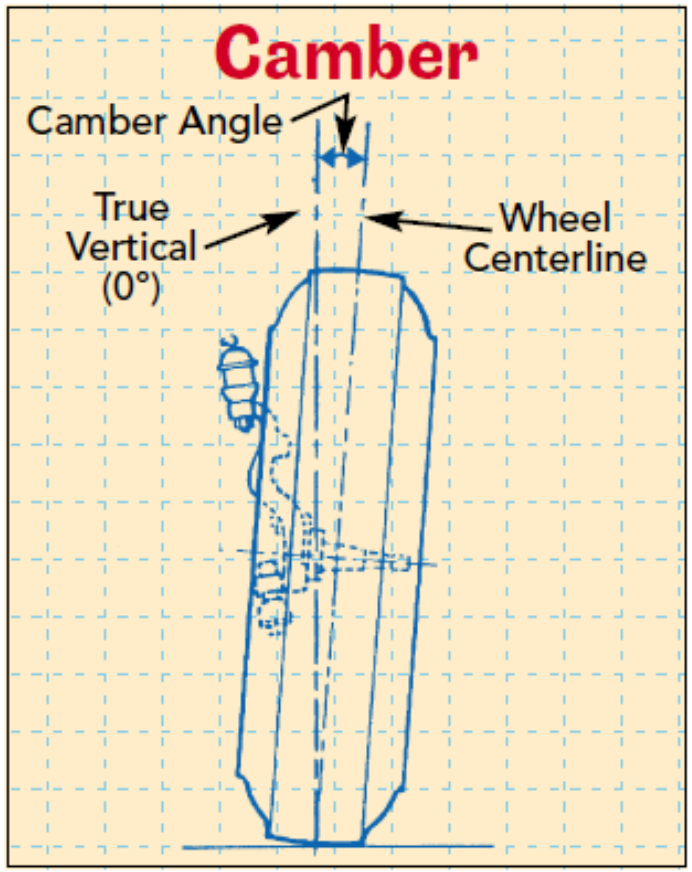
1. Factors pertaining to wheels
2. Steering Geometry
3. Steering Linkages
4. Suspension system

Factors Pertaining to wheels

1. **Balance of wheels**: Wheels are need to be in proper dynamic balance.
2. **Inflation of tyres:** Variation of air pressure from standard prescribed will change the rolling radius.
3. **Brake adjustment:** If the Brake adjustment is not adjusted properly , it can pull the vehicle to one side.

Steering Geometry

- **Camber**
- **Definition**:
- Camber is the tilt of the car wheels from the vertical .
- OR
- Camber is the tilt of the wheel from true vertical as viewed from the front of the vehicle.
- Camber is measured in degrees of an angle. (Camber should not generally exceed 2^{o})
- Also called as **Wheel rake**


Camber
Camber Angle
True
Vertical
(0°)
Wheel
Centerline

- If the tire appears to tilt outward at the top, the camber angle is **positive.**
- If the top of the tire tilts inward, the camber angle is **negative.**

Effect of Camber:

- It is always desirable that tyres should roll on the ground vertically , so that the wear is uniform.
- If while running the tyres are inclined from the vertical (either inward or outward) they will wear more on one side than the other.
- Because of positive camber , the rolling radius at different points of tyre is different as a result of which tyre tend to roll like a truncated cone. Thus tendency of wheel would be to toe out , as a result tyre will wear more on outer side.

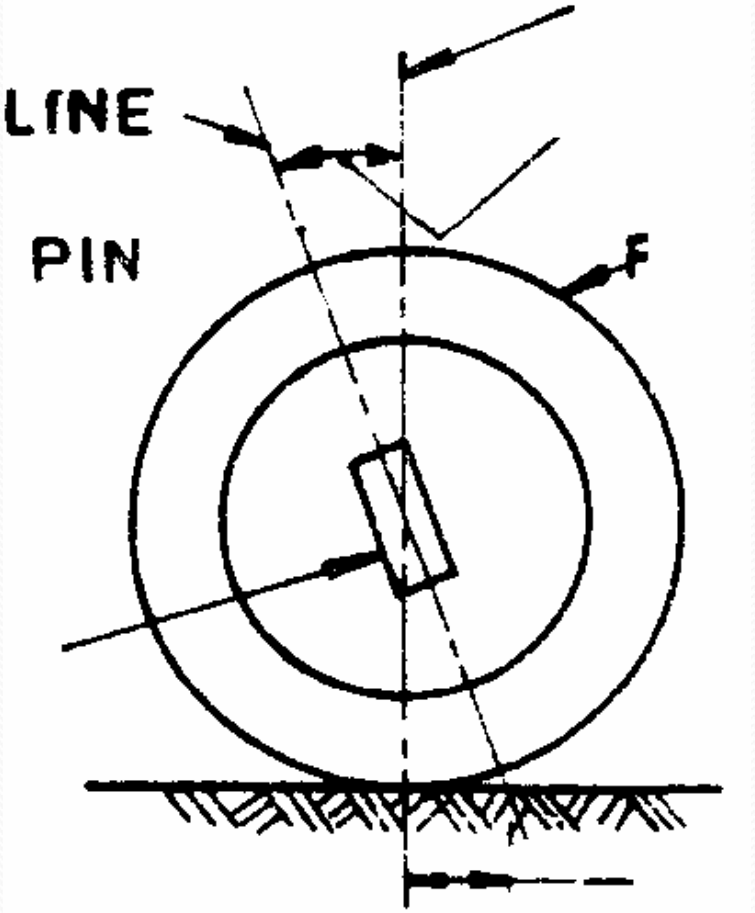
- Negative camber will cause the front wheels to toe in and wear more on insides.
- Obviously tyre life will be maximum when camber angle in running condition is Zero with average load.
- A positive camber causes the vehicle to toe out therefore If the camber on the two front wheels is not equal, the vehicle will try to pull towards the side where the camber is higher.
- On conventional rigid axle , camber remains almost fixed , However in Independent suspension usually the change of spring height changes the camber.

- **King Pin Inclination(Steering Axis Inclination)**
- **Definition:** Inclination of the king pin from vertical is called the king pin inclination or king pin rake.
- In Modern cars where the king pin has been replaced by the ball joints , this term has also been renamed as "**Steering Axis Inclination**" and is defined as the inclination of the ball joint-axis from the vertical.
- Steering axis is the imaginary line drawn through the lower and the upper steering pivot points.

- **Effect:**
- King pin inclination (or Steering axis inclination) helps the straight ahead recovery , thus providing directional stability.
- Amount – About 7 to 8 degrees.

- **Castor:**
- The angle between the king ping centre line(or steering axis) and the vertical, in the plane of the wheel is called the castor angle.
- If the king pin centre line meets the ground at a point in the front of the wheel centre , it is called positive castor , while if it is behind the wheel centre line , it is called negative castor.

Castor

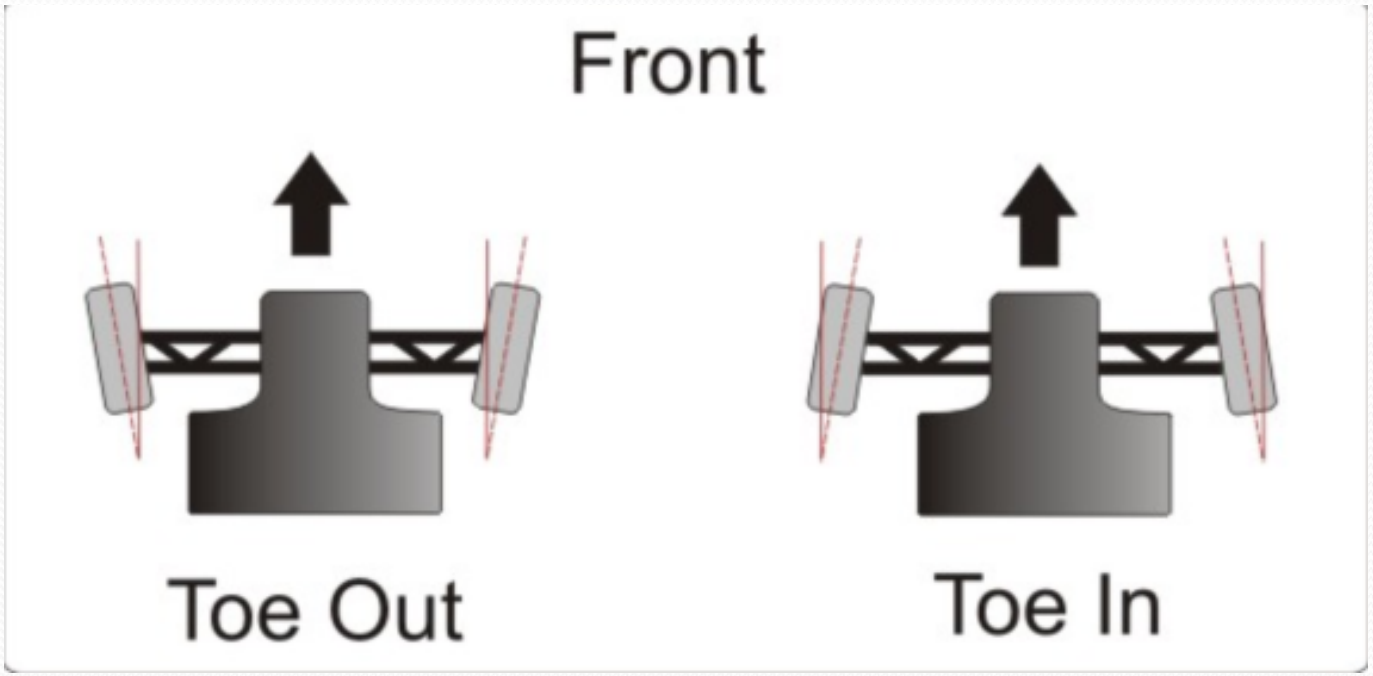


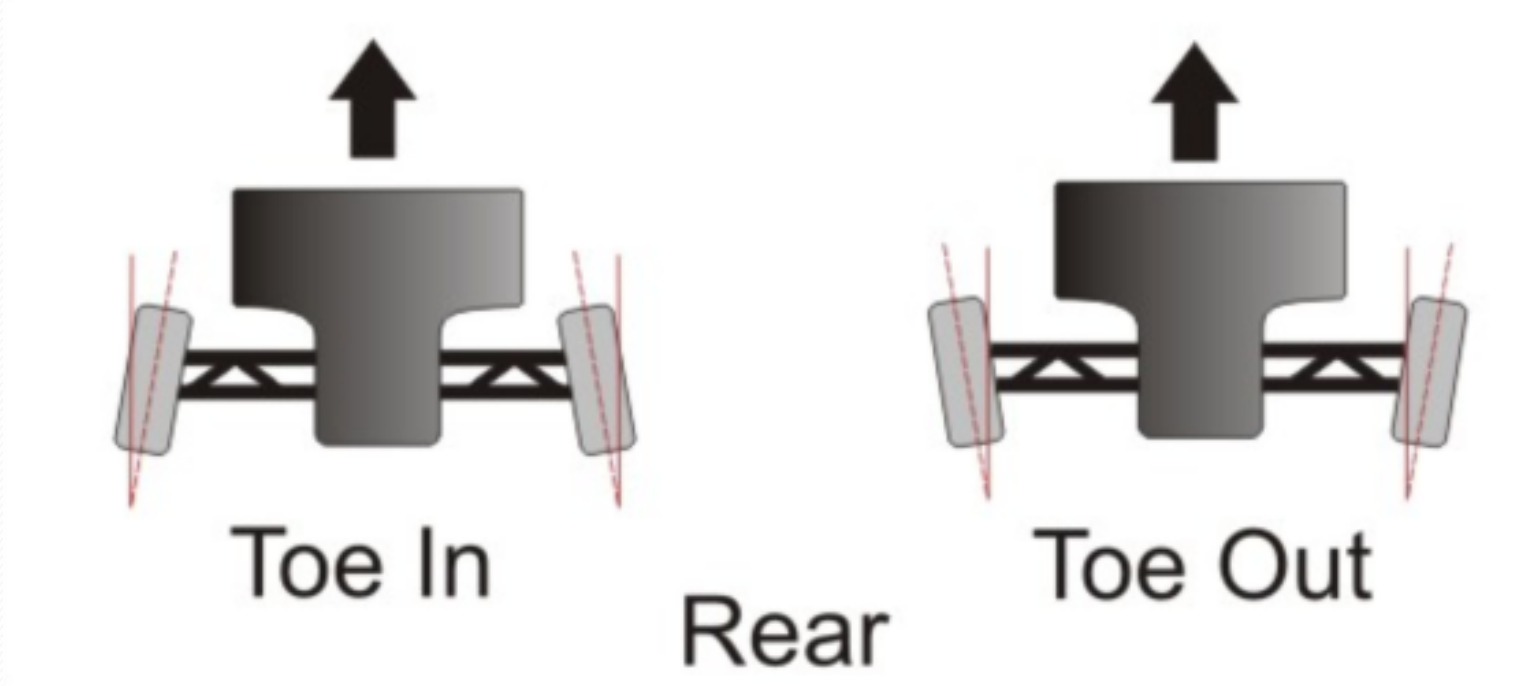
Effect

- Positive Castor Provides directional stability
- Positive castor is often used with SAI on automobiles with power steering to provide the required returnability.
- Positive castor in wheels results in a natural tendency in wheels to toe-in , thus it helps the centrifugal force in rolling out the vehicle.
- The negative castor results the wheels to toe out.
- Amount – About 3^0 of castor gives good results.

Toe-in or Toe-out

- **Definition:**
- Toe-in is the amount by which the front wheels are set closer together at the front than at the rear when the vehicle is stationary.
- The wheels may be set closer at the rear wheels than at the front in which case the differences of the distances between the front wheels at the front and at the rear is called Toe-out.


Front
Toe Out
Toe In


Toe In
Toe Out
Rear

- **Effect:**
- There is usually an inherent tendency for the wheels to toe-out because of purposeful deviation from centre point steering and also due to errors in steering angle.
- To offset this tendency , a small out of toe-in is initially provided so that wheels move perfectly straight ahead during normal running conditions.
- **Amount:** Toe-in initially provided generally does not exceed 3 mm.

Steering Linkages

- Depends on the type of vehicle having Independent Front Suspension or Rigid axle type front suspension.
- Steering linkage for vehicle with rigid axle front suspension.
- Steering linkage for vehicle with rigid Independent front suspension.

- The drop arm (also called Pitman arm) is rigidly connected to the cross-shaft of the steering gear at its upper end, while its lower end is connected to the link rod arm through a ball joint.
- Stub axle is rigidly attached to the other end of link rod arm.
- Each stub axle is has a forged track rod arm rigidly bolted to the wheel axis.
- The other end of track rod arms are connected to track rod by means of ball joints.

- The design of these ball joints is such that the expanding spring compensate for wear or maladjustments.
- An adjuster is also provided in the track rod to change its length for adjusting wheel alignment.

Steering linkage for vehicle with rigid axle front suspension

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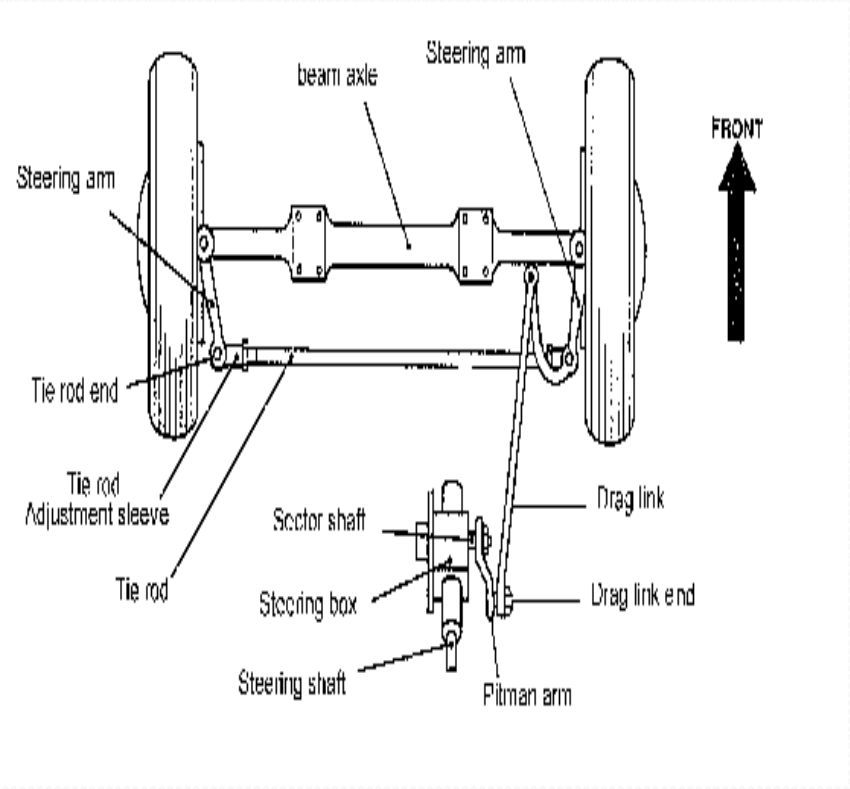


Steering linkage for vehicle with rigid Independent front suspension

- In case of conventional rigid axle suspension , the main axle beam ensures the movement of stub axle in the horizontal plane only , there is no vertical deflection of the suspension and hence there is no change in the effective track-rod length.
- In case of Independent suspension , the two stub axles can move up or down independent of each other due to which distance between ball-joint ends of the two track rod arms is continuously varying.
- Here three piece track rod is used , the centre portion being called relay rod is used , which is connected at one end to the idler arm supported on body structure and to drop arm of steering gear at the other end through ball joints

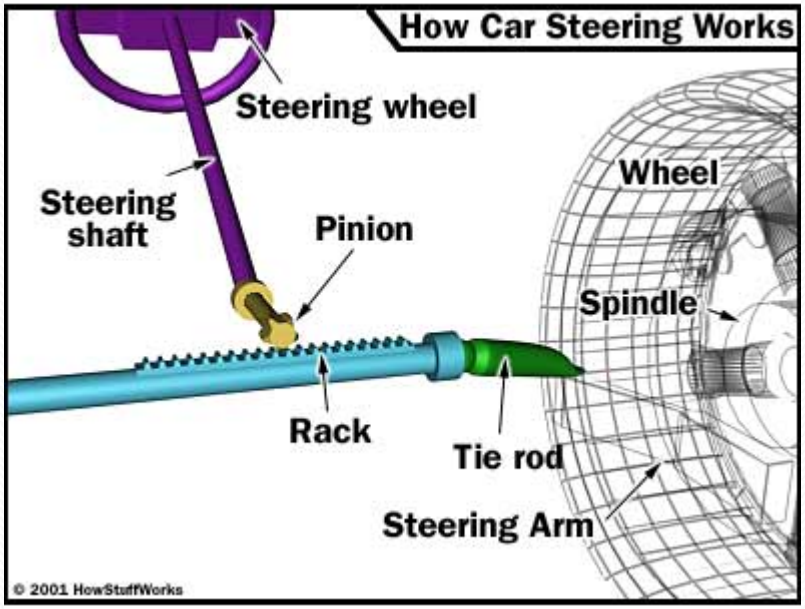
Steering gear

- The steering gear converts the turning motion of the steering wheel into the to-and –fro motion of the link rod of the steering linkage.
- **Types:**

1) Worm and wheel steering gear
2) Cam and double roller steering gear
3) Worm and nut steering gear
4) Recirculating ball type steering gear
5) Rack and pinion steering gear

Rack and Pinion steering gear

- This type of steering gear is use on light vehicles like cars and in power steering.
- It occupies very small space and uses lesser number of linkage components compared to worm and wheel type of gear
- The rotary motion of the steering wheel is transmitted to the pinion of the steering gear through universal joints.
- The pinion is in mesh with a rack.
- The circular motion of the pinion is transferred into the linear rack movement , which is further relayed through the ball joints and tie rods to the stub axles for the wheels to be steered.

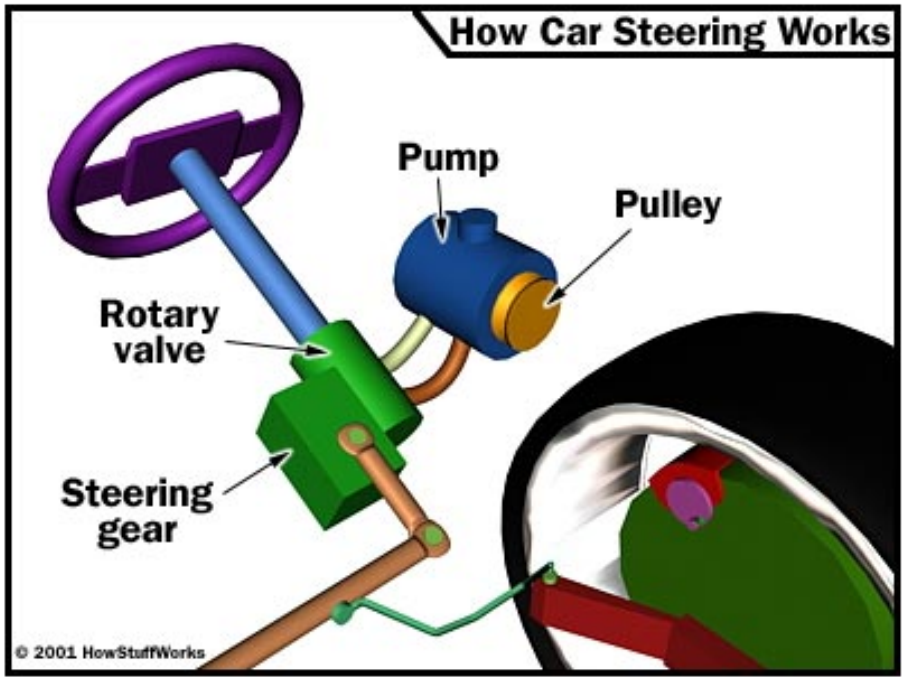


- The rack-and-pinion gear set does two things:
- It converts the rotational motion of the steering wheel into the linear motion needed to turn the wheels.
- It provides a gear reduction, making it easier to turn the wheels.

Power steering

- Larger amount of torque is required to be applied by driver for steering of medium and heavy vehicles.
- The power steering system provides automatic hydraulic assistance to the turning effort applied to the manual steering system.
- The system is so designed that in case of failure of the power system , the driver is able to steer manually with increased effort.

- The power steering system are operated by fluid under pressure.
- The principle of working of all steering system is same.
- The slight movement of the steering wheel actuates a valve so that fluid under pressure from the reservoir enters on the appropriate side of the cylinder, thereby applying pressure on one side of a piston to operate the steering linkage , which steers the wheel in appropriate direction


How Car Steering Works
Pump
Pulley
Rotary valve
Steering gear
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Electronic power steering

- Advantages over currently used hydraulic power steering:
- No problem of leakage of fluid
- Energy being consumed only while steering.
- Steering assistance available even when the engine is not running
- While steering manually lesser force is required compared to hydraulic system since there is no fluid to be forced through valves.

ACKERMAN PRINCIPLE OF STEERING MECHANISM

- The main function of the steering system of a vehicle is to convert the rotary movement of the steering wheel into angular turn of the wheels.
- For perfect steering we must always have an instantaneous centre about which all the wheels must rotate
- For this purpose inner wheel has to turn more than the outer wheel. To achieve two types of mechanisms, fate been devised.
- Straight the Davis and ackerman steering mechanism

- Out of these Ackermann mechanism it almost universally used. Referring in the Ackermann steering mechanism the track rod is placed behind the axle beam.
- The track arms AB and CD are suitably inclined to each other. This system gives true rolling of the wheels in three positions of the stub axles.
- One when the wheels are parallel and the other two cinch corresponding to the turn to left or right. In any other Position the axes of the stub axles do not intersect on the axis of the rear wheels.