STEERING & STEERING GEOMETRY

ⓐ INTRODUCTION :-

- Steering system, in automobile, steering wheel, gears, linkages, & other components used to control the direction of a vehicle's motion.
- Mainly steering steering is used to convert the rotational motion of the steering wheel into linear motion that turns the wheels & guides your path.
- This system allows a driver to use only light forces to steer a heavy car.

ⓐ PURPOSE OF STEERING SYSTEM :-

- The steering system allows the driver to guide the car along the road & turn left or right as desired.
- The system includes the following -

(i) the steering wheel :- which the driver controls.
(ii) the steering gear :- which changes the rotary motion of the wheel into straight line motion.
(iii) the steering linkages :- which transmit the steering gear movement to the front wheel.

ⓐ REQUIREMENTS OF STEERING SYSTEM :-

following are the requirements of a good steering system -

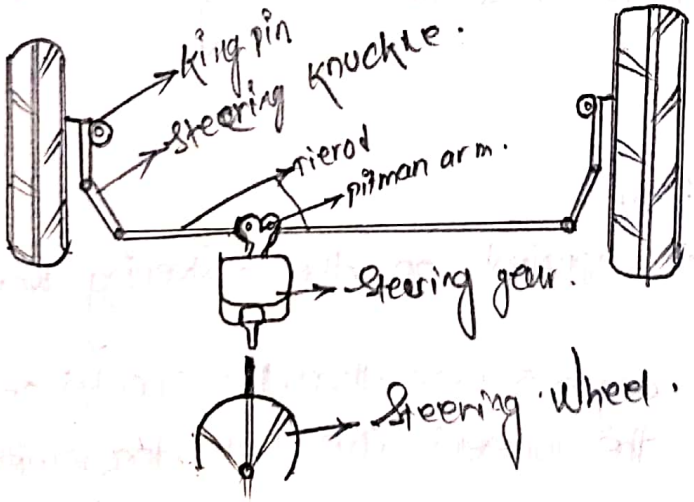
- very accurate.
- Easy to handle.
- Provide directional stability
- Multiply the turning effort applied on the steering wheel by the driver.
- Irreversible to a certain degrees, so that the shocks of the road surface encountered by the wheels are not transmitted to driver's hand.
- It must light & stable.

⊛ FUNCTION'S OF STEERING SYSTEM :-

- The primary function of the steering system is to achieve angular motion of the front wheels to negotiate a turn.
- to provide directional stability of the vehicles when going straight ahead.
- to facilitate straight ahead recovery after completing a turn.
- to minimize wear & tear of tyres.
- to absorb a major part of the road shocks there by preventing them to get transmitted to the hands of the driver.
- to provide perfect rolling motion of the road wheels at all times.

⊛ COMPONENT'S OF STEERING SYSTEM :-

- steering wheel.
- steering column or shaft
- steering gear.
- drop arm or pitman arm
- drag link
- steering arm.
- track arms
- track rod or tierod,
- adjusting screws.

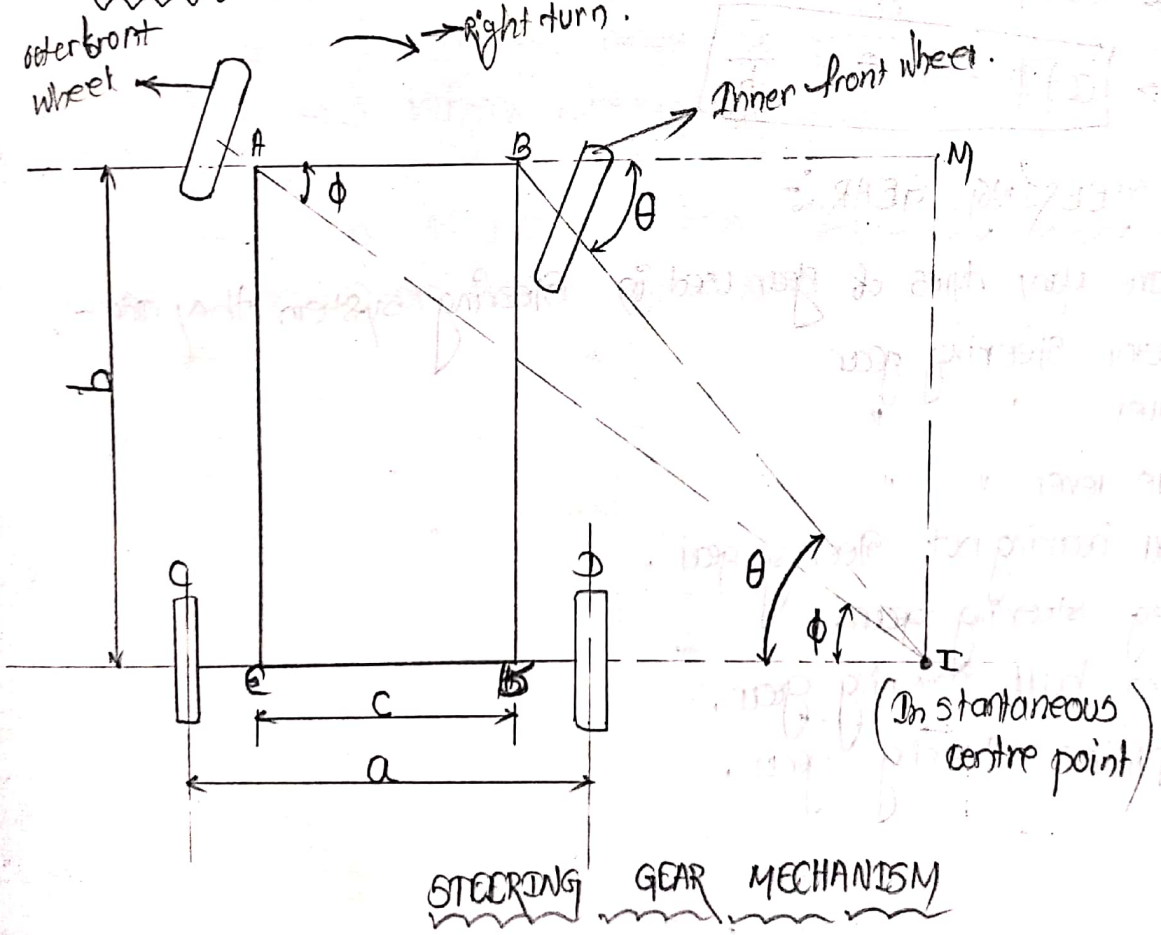


ⓐ STEERING MECHANISM :-

Fundamental Equation for correct Steering Angle :-

- The perfect steering is achieved when all the four wheels are rolling perfectly under all condition of running.
- While taking turns the conditions of perfect rolling is satisfied if the axes of the front wheels meet the rear wheel axis at one point. this is the instantaneous centre of the vehicle.
- The inside wheel is required to turn through a greater angle than the outer wheel.
- The larger the steering angle, the smaller the turning circle. The maximum steering angle of the inner wheel is about 45°.
- The extreme positions on either side are called "lock" position. The dia. of smallest circle which the outer front wheel can transverse of obtained when the wheels are at their extreme position is known as the "turning circle".

ⓐ CORRECT STEERING ANGLE :-



STEERING GEAR MECHANISM

- The condition for correct steering is that all the four wheels must turn about the same instantaneous centre.
- the axis of the inner wheel makes a larger turning angle ϕ than the angle 'ϕ'.
- subtended by the axis of outer wheel.

let a = wheel ~~base~~ track
b = wheel base
c = distance between the pivots A & B of the front axle.

In ΔIBM,

$$\cot\theta = \frac{BM}{IM}$$

ΔIAM,

$$\cot\phi = \frac{AM}{IM} = \frac{AB + BM}{IM}$$

$$= \frac{AB}{IM} + \frac{BM}{IM}$$

$$\Rightarrow \cot\phi = \frac{c}{b} + \cot\theta$$

$$\Rightarrow \boxed{\cot\phi - \cot\theta = \frac{c}{b}}$$

⊛ TYPES OF STEERING GEAR :-

There are many types of gear used in steering system, they are -

- worm & sector steering gear
- worm & roller " "
- cam & double lever " "
- worm & ball bearing nut steering gear.
- cam & peg steering gear.
- Recirculating ball steering gear.
- Rack & pinion steering gear.

⊛ STEERING GEOMETRY :-

➤ the term "steering geometry" (also known as "front-end geometry") refers to the angular relationship between suspension & steering parts, front wheels, & the road surface. Because alignment deals with angles & affects steering, the method of describing alignment measurements is called steering geometry.

there are five steering geometry angles -

(I) camber
(II) caster
(III) king pin inclination
(IV) toe-in & toe-out.

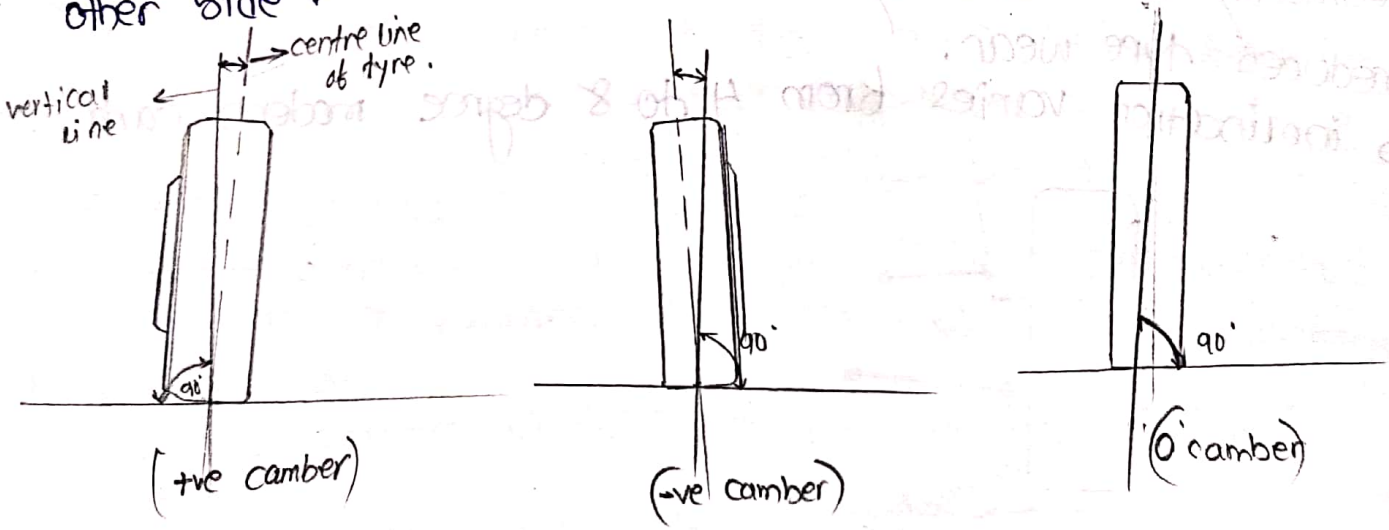
CAMBER :-

➤ Camber angle is the angle between the vertical line & centre line of the tyre when viewed from the front of the vehicle.

➤ camber angle is positive when this is outward. this happens when wheels are further apart at top than at bottom.

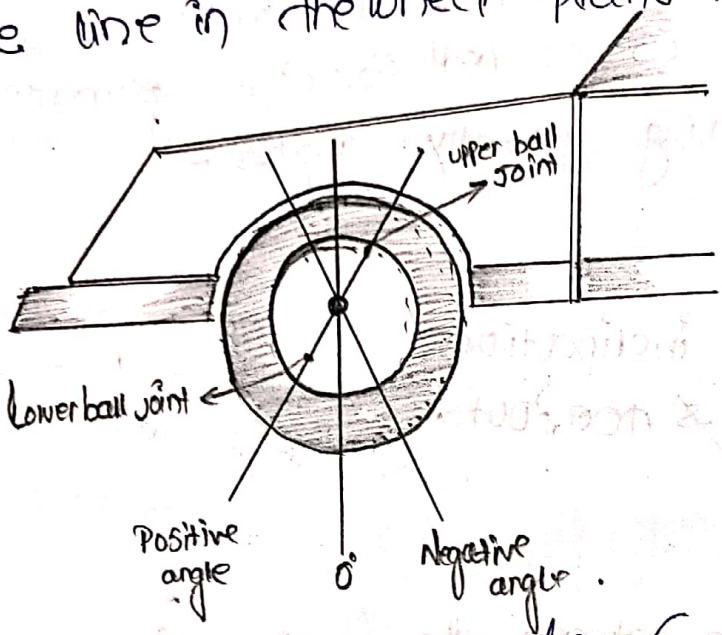
- on the country, camber angle is negative when angle is inward. this happens when where are further apart at bottom that at top.

➤ the camber, should not be more than 2°, because this causes uneven or more tyre wear on one side than on other side.



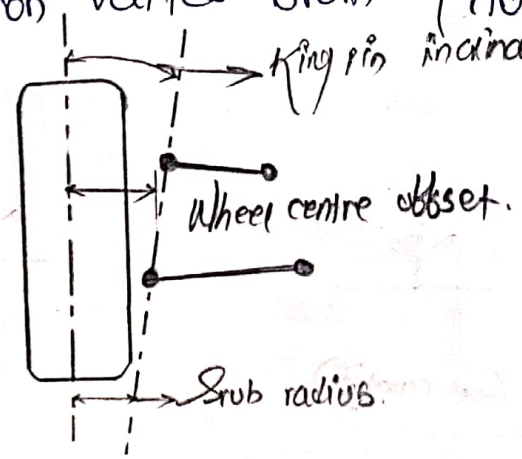
CASTER :-

- caster angle is the tilt of king pin centre line towards front or back from the vertical line.
- It is the angle between the vertical line & king pin centre line in the wheel plane when looked from side.



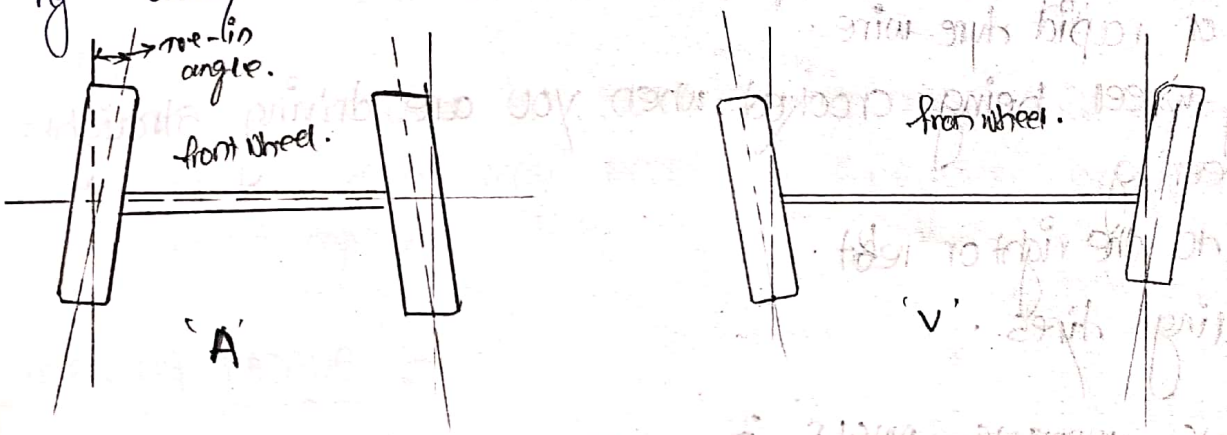
KING PIN INCLINATION :- / SAI (steering axle inclination).

- It is the angle between the king pin centre line & vertical line when seen from the front of the vehicle.
- It is also called steering axle inclination (SAI).
- King pin inclination & caster ~~incli~~ are used to improve direct and stability in cars.
- This is also used to reduce steering effect when steering ~~a~~ a ~~stationary~~.
- It reduces tyre wear.
- This inclination varies from 4 to 8 degree modern cars.



TOE-IN & TOE-OUT :-

- In automotive Engg., toe also known as tracking.
- this can be constructed with steer, which is the anti symmetric angle, i.e, both wheels point to the left or right, in parallel (roughly).
- positive toe, or toe-in, is the front of the wheel pointing in towards the centreline of the vehicle.
- Negative, or toe-out, is the ~~back~~ front of the wheel pointing away from the centreline of the vehicle.



UNDER STEER :- (কম্ ঘুৰণি)

- It occurs when the front wheels start to move straight even if you turn the steering.
- this problem occurs in front-wheel drive vehicles.

OVER STEER :- বেছিকৈ ঘুৰণি

- It occurs when back of the car is being kicked.
- this problem common for rear-wheel line vehicles.

COMBINED ANGLE / Included angle =

- combined angle or inclined angle is the angle formed in the vertical plane between the wheel centre line ~~& king pin~~ (steering axis).
- combined angle is equal to camber plus kingpin inclination (or SAI).
- combined angle may be 9° to 10°.

⊛ WHEEL ALIGNMENT :-

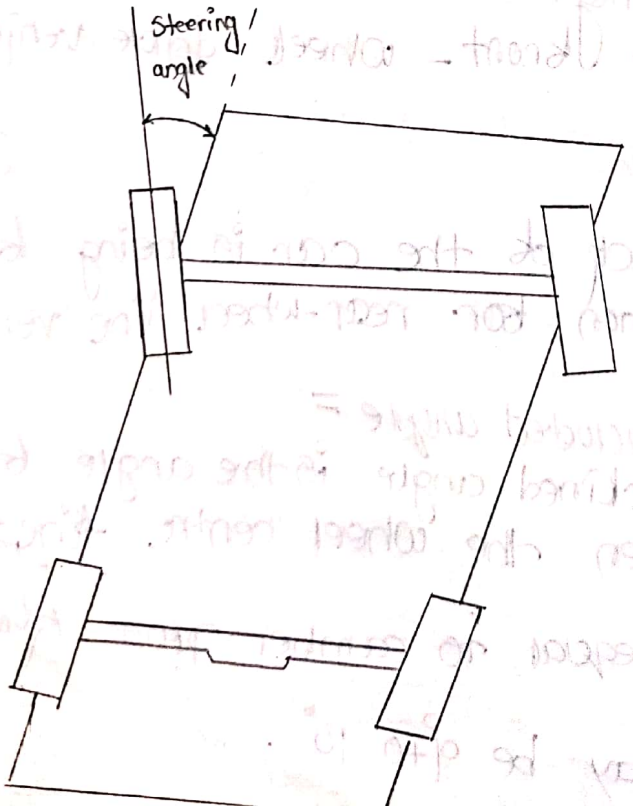
- Wheel alignment refers to an adjustment of a vehicle's suspension, or the system that connects a vehicle to it's wheels.
- It is not an adjustment of the tyres or wheels themselves.
- The key to proper alignment is adjusting the angles of the tyres which affects how they make contact with the road.

Effect of incorrect wheel alignment :-

- Uneven or rapid tyre wire.
- Steering wheel being crooked when you are driving straight.
- Noisy steering
- Pulling to the right or left.
- Squealing tires.

⊛ STEERING TURNING ANGLE :-

- The steering angle is defined as the angle between the front of the vehicle & the steered wheel direction.

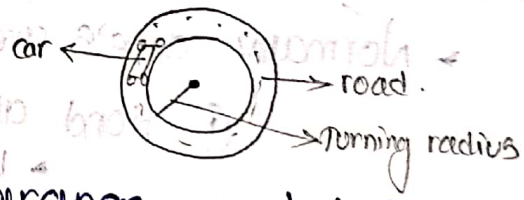


Turning angle or toe-out on turns ?

- Turning angle also refferred to as toe-out on turns, describes the difference in side to side steer angles of the front wheel as the vehicle turns.
- Created by the angle of the steering arms, turning angle allows the outside wheel on a turn to steer at a lesser angle than the inner wheel.
- This is necessary because the outer wheel has to travel a larger radius, otherwise the tyre may scuffs when the vehicle turns.
- If a steering arm is bent turning angle will change. Large turning angle errors may lead to irregular shoulder wear on the front tyres.

TURNING RADIUS :-

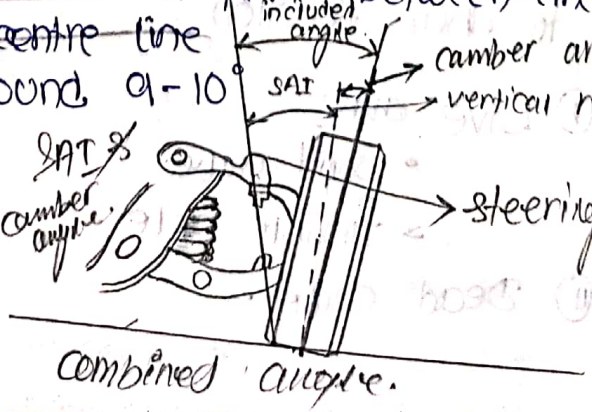
- Turning radius is the radius of the smallest circle in which car can turn.
- It is measured by 'meter'.
- Turning radius is the minimum clearance needed to turn a car.
- Turning radius depends on two things one is: the wheel base & another one is - the angle of the front wheel.



COMBINED angle / Included angle :-

(SAI + camber) (SAI + camber)

- The angle formed in the vertical plane between the king pin centre line & the wheel centre line
- Included angle is around 9-10°
- " " includes SAI & camber angle
- Viewed from front.



FRONT AXLE

⊛ AXLE :-

★. An axle is a central shaft for a rotating wheel or gear which is used

- A wheeled vehicle, the axle may be fixed to the wheels, rotating with them or attached to its surrounding with the wheel rotating around the axle.
- In the former case, bearings or bushes provide at the mounting points where the axle is supported.
- For cars & trucks, the shaft itself rotates with the wheels being bolted or splined in fixed relation to it & is called an axle or axleshaft. However, it is genuinely the surrounding housing that is called an axle or axle housing.

⊛ CLASSIFICATION OF AXLE'S :-

- Normally axle's are two type's.
  - (I) Front axle
    - Live axle
    - Dead axle.
  - (II) Rear axle.
    - Full-floating
    - Semi- "
    - Three quarter floating.
- According to their function
  - (I) Live axle
    - Solid axle
    - Flexible axle.
  - (II) Dead axle.

→ Stub axles are four types -

(I) Elliot type
(II) Reverse Elliot type
(III) Lamoin type.
(IV) Reverse lamoin type.

Front axle :-

- The front axle uses to carry the weight of the front part of the vehicle as well as to facilitate steering & absorb shocks due to road surface variations.
- It is made of I-Section in centre position while the ends are made either circular or eliptical with the construction.
- It takes bending loads & also torques due to braking of the wheel. To keep the low chassis heights, it's centre portion gives a down step sweep. Some times it also transmits torque from differential to the drive wheels.

FUNCTION OF FRONT AXLE :-

→ It supports the weights of front part of the vehicle.
→ It facilitatates steering
→ It absorbs shocks which are transmitted due to road surface irregularities.
→ It absorbs torque applied on it due to braking of vehicle.
→ Some times it transmits torque from differential to the drive wheels.

1. It turns the front wheel easily.
2. It provides a cushioning effect through a spring
3. It takes the weight of front of vehicle.

4- It provides steering action.
5- The spring transmits cushion effect to the vehicle.
6- It controls the ride through shock absorber.
7- It takes the braking system.
8- It transmits power to the front wheels in case of four wheel drive.
9- It carries the hub & wheels.

CONSTRUCTION OF FRONT AXLE :-

The front axle has different components like -

- Axle Beam
- Stub axle
- King Pin
- Track rod. → Pull & push rod or drag link

① STUB AXLE :-

- The front wheels are mounted on the stub axles, which are connected to the front axle by means of king pins.
- The stub axles are the forging of Nickel steel and alloys steel containing chromium & molybdenum.
- The stub axle turns about the king pin which is a light drive fit in the axle beam eye located & is locked by the taper cotter pin.
- Phosphor bronze bushes are fitted into the forked ends of the axle to provide a bearing surface for the king pin.
- A steel thrust washer is provided to take the vertical load in the joint.

TYPES OF STUB AXLE'S :-

There are 4 types of stub axles are used -

① ELLIOT TYPE -

- This stub axle's is attached to the front axle by placing it in the yoke end with a king pin & a cotter to join the two together.
- The swivel pin is usually bived in the stub axle forging with it's purposes turning in the forced closing of the axle beam.
- Axle beam forms as a yoke & receives stub axle. The thrust washer place at the top portion of the stub axle.

sketch -

⑪ REVERSE ELLIOT TYPE :-

- The reverse elliot type stub axle forms the fork end to recei the front axle beam. The front axle end form a eye & thrus washer place at the bottom of the front axle beam that is at the contact face with the stub axle.
- The cotter pin in the joint that locks the movement of the king pin in the front axle. The king pin is free to move in the phosphor bronze bushes placed in the eye of the fork en
- The thrust washer takes vertical load in the joint & it's use t increase the life of both the stub axle & front axle.

- Stub axle forms as a yoke & receives the front axle. thrust washer placed at the bottom.

Sketch -

(III) LAMOINE TYPE :-

- The front axle beam end forms the eye to take support on the stub axle. The stub axle & king pin integrates to create reverse 'L' shape assy receives the front axle.
- The thrust washer place between the stub axle & front axle beam. Here the cotter pin in the joint is used to lock the front axle in position.
- The king pin is free to move in the bushes placed in the eye of the front axle. The thrust washer takes the vertical load in the joint.

Sketch -

(IV) REVERSE LAMOINE TYPE :-

- The front axle beam- ends forms eye to take support the stub axle. The stub axlse & king pin integrates to form an inverted 'L' shape assy to receive the front axle.
- The thrust washer is placed at the bottom. The cotter pin in the joint use to lock the front axle in position. The king

pin is free to move in the bushes placed in the eye of the shaft. the thrust washer takes the vertical load & it increases the life of both the stub axle & front axle.

sketch -

② AXLE BEAM :-

- Axle beams are made by drop forging of steel having 0.4% carbon or 1-3 % nickel steel.
- The front axle beam is formed into I- section in the centre position. the ends are made into either circular or elliptical.
- I- section construction carries bending loads caused by the load of the vehicle & torque by braking of wheels.
- The centre portion of the front axle is provided a downward sweep to maintain the chassis height low.
- The axle beam is already hinged with stub axles. springs are mounted on the axle beam at equal distance from it's centre known as spring Pads or seats.
- Basically axle beam's are 3 types -
  - (i) Straight axle Beam
  - (ii) Double drop " "
  - (iii) full " " ".

③ KING PIN / SWIVEL PIN :-

- The steering spindle & steering knuckle assy are pinned at the ends of axle beam in order to permit wheels to be turned

by the steering gear. This pin is known as king pin or steering knuckle pin. It is also called swivel pin. This pins are made of good quality case hardened steel used to secure the stub axle to the axle beam. It is exactly located & locked by cotter pins in position.

④ TRACK ROD -

- the two stub axles arms of the front axle are connected with ends of a track rod through knuckle or ball joints known as track rod ends.
- the connection is done by screws to ensure adjustments. in the stub axle, left hand & right hand threads are formed at each end.
- Toe-in is increased by lenthening the rod & it is decreased by shortening the same.

⑤ PULL & PUSH ROD (or) DRAG LINK :-

- Pull & push rod also called drag link is connected between steering arm of the front axle & drop arm of the steering assemble.
- But the cross-section is tubular. spring loaded ball socket are provided at each end.
- one end is connected to the steering arm of the stub axle. whereas the other end is connected to the steering drop arm.

⊛ TYPES OF FRONT AXLES :-

there are two types of front axles based on the rotation as follows -

① Live front axle
② Dead front axle.

- Generally, the front axle is a dead axle, In heavy vehicles and most of cars, the front axle is a live axle.
- This type of axles are used in modern cars & heavier vehicles. The front axle's are called as dead axles when they don't rotate but live axle's transmit power to rear wheels.
- A live front axle also transmits the driving power to front wheels having different swivelling mechanisms.
- The dead front axles has enough rigidity & strength to transmit the weight of vehicle from springs to front wheels.

SUSPENSION SYSTEM

⊛ INTRODUCTION :-

- A system of mechanical linkage, springs, dampers that is used to connect the wheels to the chassis is known as suspension system.
- This system controls the vehicle's handling & braking for safety & keeping the passengers comfortable from bumps, vibration etc.

⊛ FUNCTION OF SUSPENSION SYSTEM :-

- To prevent road shock from reaching the frame of the car.
- Maintaining the stability while driving.
- To protect the passengers in the car from the shock of the road
- Keeping the grip of the wheels off the road while driving, turning & applying brakes.
- Maintaining correct steering geometry.
- It provides cushioning effect.
- It provide comfort.

⊛ REQUIREMENTS OF SUSPENSION SYSTEM :-

- There should be minimum deflection.
- It should be low initial cost.
- It should be of minimum weight.
- It should have low maintenance & low operating cost.
- It should have minimum tyre wear.

⊛ TYPES OF SUSPENSION SPRING :-

(I) Leaf Spring
(II) Coil Spring
(III) Torsion bar.
(IV) Rubber torsion Spring
(V) Air bags

① LEAF SPRING :-

- Leaf spring consists of number of strip's, each strip is named as leaf.
- They are made of long strips of steel.
- All the leaf's are clamped by a centre bolt at the centre.
- The 'U' bolt & clamps are located at the intermidiate position of the spring.
- The long leaf is called master leaf & it consists of eye's as it's both ends.
- One end is fixed to the chassis frame, the other end is fixed to the shackle spring.
- The spring will get elongated during expansion & shortened during compression
- The change in length of spring is compensated by the shackle.
- The bronze bush or rubber bushes are provided on both eyes on the master leaf.
- originally called a laminated or carriage spring.

Sketch:-

- Types of leaf spring :-

There are six type's of leaf springs -

(I) Full eliptical spring
(II) Semi-eliptical "
(III) Quarter eliptical "
(IV) Three-quarter eliptical spring.
(V) Transverse spring type.
(VI) Helper spring type.

(II) COIL SPRING :-

- The coil springs are used mainly with independent suspension system.
- Coil springs are made with of spring steel.
- The energy stored per unit volume is almost double in case of coil springs than the leaf springs.
- Coil spring do not have noise problems, nor do they have static friction.
- The spring takes the shear as well as bending stresses.
- The coil springs, however can not take torque reaction & side thrust, for which alternative arrangements have to be provided.
- A helper coil spring is also sometimes used to provide progressive stiffness against increasing load.

(III) TORSION BAR :-

- Torsion bar suspension is used in independent suspension system.
- It is a rod acting in torsion & taking shear stresses only.

- It is made up heat treated alloy spring steel.
- this bar stores amount of energy nearly as same as coil spring.
- the bar is fixed at one end to the frame, while the other end is fixed to the end of the wheel arm & supported in the bearing.
- the other end of the wheel arm connected to the wheel hub.
- when the wheel strikes a bump, it starts vibrating up & down, thus exerting torque on the torsion bar which acts as a spring.

(iv) RUBBER TORSION UNIT SUSPENSION :-

- the rubber torsion suspension has a rod attached to the swing arm supporting the wheel, with the rod located inside an outer housing by a rubber torsion spring.
- the other end of the tube is attached to the chassis by a similar rod & rubber torsion spring.
- the outer tube can then move relative to the rods & chassis to provide an extra degree of freedom for the suspension.
- this provides an initial soft spring characteristic for smooth damping, followed by a harder characteristic when the second rubber insert is twisted.
- the movement of the outer tube is limited by stops so that the overall characteristics of the system can be preset by the position of the stops.

TYPES OF SUSPENSION SYSTEM :-

- Conventional / Rigid axle / Depended suspension system
- Independent suspension system
- Air suspension system
- Hydro elastic suspension system
- Stabilize / Antiroll bar / sway bar suspension system.

① RIGID AXLE SUSPENSION SYSTEM :-

- Left & right wheels are connected together with a solid link between them.
- one wheel movement affects the other.

- A suspension system in which both the right & the left wheels of the front & the rear pair of wheels are connected with a solid axle in such a way that the upward motion due to the bump in any one wheel of the front & rear wheels pair causes slight tilt in the other.

- Two wheels are mounted on either side of the rigid axle.
- When one wheel encounters the bump, both the wheel do not execute parallel up & down motion.
- So it gives rise to gyroscopic effect & wheel wobble.
- Rear driving wheels mounted on live axle suspended by laminated leaf springs & shock absorbers.

(II) INDEPENDENT SUSPENSION SYSTEM :-

- The left & right wheels are not connected together by a solid link & can move independently of each other.
- If one wheel goes down, then the other wheels does not have much effect.
- This suspension system that allows each wheel on the same axle to move vertically (i.e reacting to a bump on the road) independently of the others.
- This suspension system provides better ride quality & handling characteristics, due to lower unsprung weight & the ability of each wheel.
- This suspension system mainly devided into 4 types they are -
  - (I) Double wishbone suspension
  - (II) Mac-pherson strut
  - (III) Multi-link suspension
  - (IV) Transverse leaf - spring.

(I) DOUBLE WISHBONE SUSPENSION SYSTEM :-

- In automobiles, a Double wish bone suspension is an independent suspension design using two ('A' shaped ctrl arm or occasionally parallel) wishbone shaped arms to locate the wheel.
- As the name suggests, Double wishbone or Double-A suspension set up has the shape of a bone found in birds.
- Each wishbon or arm has two mounting points on the chassis & one joint at the knuckle.
- The shock absorber & coil spring mount to the wishbones to control the vertical movement.

- one arm of the wishbone is shorter (upper arm) than the other one (lower arm)
- As a result of this, during cornering, the tyre remains in contact with the ground because of camber gain.
- The spring & damper placement are also very flexible according to the availability of space.
- Double wishbone set up is one of the best suspension systems out there at the moment.

(ii) MACPHERSON STRUT TYPE SUSPENSION SYSTEM :-

- The most widely used independent suspension system is the Macphesion strut.
- Almost every passenger car's used this set up at the front end & a similar coil spring at the rear.
- Macphersion strut includes a simple assy of coil spring & a damper/shock absorber.
- The task of the spring is to store the energy from a sudden jerk from the road.
- The damper uses hydraulic fluid to dissipate this energy in form of heat.
- Together they restrict any unwanted movement/shocks/vibration of the car because of undulations on the road.

(*) COMPONENT'S OF SUSPENSION SYSTEM'S :-

a) Knuckle - It is the component of the suspension system that is mounted over the wheel's hub through which the wheels & the suspension of the vehicle connect with each other by the linkages provided.
- A knuckle is a stub axle that is used as a connection point between the tie rod & wheel.

- A knuckle is provided with the king-pin & the caster angles that helps the front wheels of the vehicle to steer in right or left direction which in turn steers the vehicle.
- A knuckle provides housing for central bearing over which the wheel's hub rotates along with the rotation of the wheels.

b) Spring -

- The spring's are critical components in the suspension system that absorbs the shocks & bumps while the car is in motion.
- Most of the car's have four springs that are generally designed to last the like time of the car.
- Generally it made up spring steel, & the spring is the core component of all suspension systems.

c) SHOCK ABSORBER / DAMPER -

- Shock absorbers are used mainly to minimize the shocks or vibrations that are caused by the vehicle in motion due to undulation of road surface's.
- Shock absorber's provides smooth riding for the passengers & the luggage.
- Most of shock absorber's are generally fluid filled & work in tandem with the spring to minimize the shocks & vibration that are caused by the vehicle in motion.

d) STRUT -

- Struts are components that join the spring & the shock absorber.
- In their most basic form struts provide dampening function as well as structural support for the vehicle

suspension.

- Struts & shocks are absolutely critical components in the suspension of a vehicle.

e) Stabilizer bar / sway bar / anti-roll bar :-

- It is the most important component of a vehicle's suspension system.
- Anti-roll / sway bars are used for providing further stability to the moving vehicle's.
- It is a metal bar that joints the different sides of the suspension & helps in reducing the vehicle's sway.
- It also helps to reduce the vehicle body roll during first cornering or over road irregularities.
- this bar is made up steel.

f) Ball joints -

- The vehicle suspension is designed to move up & down while the vehicle is in motion, which is connected to the spindle by ball joints.
- Ball joints are basically ball & socket joints that allows multi dimensional movements.
- Ball joints are lubricated with grease & sealed.

g) Spindle -

- The spindle is an important part of the vehicle suspension system that ties the wheel & tyre into the steering system.
- The spindle is situated in the front of most vehicles and is like a short axle that is used to attach the wheel assy to the vehicle.

⊛ ADVANTAGES of Indipendent suspension -

- Better handeling & cornering.
- Better stability & steering.
- more ride comfort.
- Lower weight.
- Riding quality is good.
- Ground clearance increases.
- less space occupies.

⊛ Is advantage of Indipendent suspension :-

- complex design
- More maintenance cost.
- More wear & tear.
- Less overall strength
- Require frequent wheel alignment otherwise increases tyre wire.

WHEELS & TYRE

⊛ INTRODUCTION :-

- The power developed by the engine & it has been transferred through the clutch, gearbox, propeller shaft & differential to the rear axle. wheels are connected to the rear axle. As the rear axle turns, wheels also turn & the vehicle moves on the road. The ultimate purpose of the power developed by the engine is to turn the wheels so that vehicle moves on the road. let's we will discuss about the wheels & tyre & tubes.

⊛ TYRE :-

- Tyre refers to the assembly of casing & tread mounted on a car wheel to provide an air cushion & contact with the road.
- The tyre is mounted on the wheel rim. It has to carry the vehicle load & provide cushioning effect absorbing braking action.
- It must produce a minimum noise, while the wheel is turning on the road.

⊛ BASIC CONSTRUCTION OF TYRE :-

- A tyre is made from rubberized fabric plies over a rubber liner & the edges of the plies are wrapped around a wire bead, which holds the tyre to the wheel rim. The fabric plies are covered with a rubber compound tread & a different rubber compound for side walls.
- The tyre is cured in a mould to vulcanize the parts into a single unit & form the tread design.

→ Main components of tyre is –

BEAD - Two rings that are made of steel wire & encased in rubber they hold tyre side walls snugly against the rim & Prevent tyre from coming off body.

PLIES - rubberized fabric & cords wrapped around beads, form carcass or body of the tyre.

TREAD - outer surface of the tyre that comes in contact with the road.

SIDEWALL - outer part of the tyre that extends from the bead to the tread. Marking on the sidewall Provides the information about the tyre.

LINER - the layer of rubber that is bonded to the inside of the plies. Provides a leak Proof membrane for tubeless tyre.

BELTS - Used to strengthen the body plies & Stiffen the tread. Lie between tread & Plies.

① CLASSIFICATION OF TYRE :

Tyres are classified into 3 categories –

1. According to tread Pattern design
2. According to carcass
3. According to construction

① According to tread pattern design tyre classified into 3 types

- Summer tyres
- Winter tyres
- All season tyres.

Summer tyre :-

they deliver excellent driving & braking Performance on wet & dry roads.

Winter tyres :-

specifically for the snow & ice covered roads.

All season tyres :-

type complex tread pattern.

(2) According to carcass, tyre classified into 3 types —

(I) Cross ply tyre :-

- Ply cords are woven at angle of 30° to 40° to the tyre axis
- two layers that runs in opposite direction however the cords are not woven like warp.

(II) Radial Ply tyre :-

- Ply cords run in the radial direction i.e in the direction of the tyre axis.
- over this runs a number of breaker strips in the circumferential direction.

(III) Belted - Bias Tyre :-

- combination of both the radial & cross Ply type.
- Basic construction is the bias ply over which run a number of breaker belts.
- the belt improve the characteristic of the bias Ply to a large extent.

(3) According to construction tyres classified into 2 types.

(I) conventional tube type tyre -

- It is a traditional tyre. It encloses a tube in which air is forced to a high pressure as a cushioning medium.
- The outer portion of the tyre which rolls on the road is made of synthetic rubber & is called tread.
- At the inner edges, beads are formed by reinforcing with steel wires.
- The beads act as strong shoulders for bearing against the wheel rim.
- Rayon cords are formed into a number of plies.
- Where the beads & cords give strength to the tyre, the treads provide resistance against slipping & thicker surface at the outer periphery.

(II) Tube less type tyre :-

- Tubeless tyre does not enclose the tube.
- The air under pressure is filled in the tyre itself. The inner construction of this tyre is almost the same as that of the tube tyre.
- A non-return valve is fitted to the rim through which the air is forced inside the tyre.
- Air retaining liner made of halogenated rubber like bromo-butyle or chloro-butyle for better performance.
- Major difference between the tubed tyre & the tubeless tyre lies in the bead area of the tyre.

- The tubeless tyres are lighter & runs cooler than tube tyre.
- The main advantage of a tubeless tyre is that it retains air for a long period even after being punctured by nail, providing the nail remains in the tyre.
- Any hole in the tubeless tyre can be repaired simply by rubber plugging.

Advantage of radial ply tyres over cross ply tyre :-

- Flexible side walls
- Reduced fuel consumption due to less rolling resistance.
- A softer ride because of the layout of the tyre's plies & because of the flex of the sidewalls, assuring more stable contact with the road service & a softer ride.
- Less vibration.
- Extended tyre life due to less heat generated by the tyre.

Disadvantage of radial ply tyre's over cross ply tyre :-

- Poor transport handling, since low lateral stiffness causes the tyre sway to increase as the speed of the vehicle increases.
- Increased vulnerability to abuse when overloaded or under inflated. The sidewall tends to bulge which could cause damage & puncture.
- A ply layout that causes the radial tyre to follow a wheel track more consistently than a bias (cross) ply tyre.

(*) - The radial tyre is more expensive than a bias cross ply tyre which may be considered as a disadvantage.
- However, the radial tyre lasts longer & this results in the savings of money over the long run.

(*) TYRE DIMESIONS :-

- Automotive tyre's described by an alphanumeric tyre code, which is generally molded into the sidewall of the tyre.
- this code specifies the dimensions of the tyre, & some of it's key limitations, such as load-bearing ability, & Maximum speed.
- Some times the inner sidewall contains information not included on the outer sidewall & vice versa.

(or)

The side wall code provides information on tyre size & construction (e.g whether they're radial), as well as their load carrying capacity & speed rating.

for Example - the code on a common cars is

205/65R1595H

205 - Indicates the normal section width of the tyre in m.m (205 m.m).

65 - Indicates it's aspect ratio, a comparision of the tyre's section height with its section width (65 indicates the height is 65% of it's width)

R - Indicates Radial Ply construction.

15 - Indicates the nominal diameter of the wheel rim (15 inch)

95H - is a symbol indicating the maximum load capacity & speed at which the tyre can be safely operated, subject to the tyre being in sound condition, correctly fitted, & with recommended inflation Pressure (95 represents a maximum load of 690 K.g per tyre; "H" represents a maximum speed of 210 Km/h).

⊛ TYPES OF TYRE DAMAGES :-

The most common damage incurred by tyres includes the following-

- Punctures
- cuts
- cracks
- Bulges
- Irregular wear to the tread

⊛ WHEEL :-

- A wheel of vehicle that transmits force, transforming torque into tractive force from the tires to the road, causing the vehicle to move.
- Most standard wheels are made of steel.
- Some vehicles are fitted with alloy wheels that are made of magnesium or aluminium.
- The rim holds the tyre.
- The well of the wheel allows the tyre to be removed & re-fitted.

→ The centre section is welded to the rim.
→ The pilot bore fits to the hub.

✱ TYPES OF WHEELS :-

① Steel wheels / Disc wheels :-

A very popular design of wheel. very strong & cheap to pro these wheels are light in weight.

② Alloy wheels :-

This wheels are attractive & light in weight, but can be difficult to clean.

③ Spoke wheels / wire wheels :-

these are used on older sports vehicles, but can not fitted with tubeless tyre.

④ Divided rims :-

These rims are made in two halves which are bolted together, the rims must never be separated while the tyre is inflated.

⑤ Split rims :-

the tyre is held in place by a large circlip, do not remove the tyre unless you have been properly trained.