

USN



Internal Assessment Test 3 – May 2023

Sub:	Automobile Engineering					Sub Code:	18ME824	Branch:	ME	
Date:	12/05/23	Duration:	90 min's	Max Marks:	50	Sem / Sec:	VIII/A&B		OBE	
<u>Answer any FIVE FULL Questions</u>								MARKS	CO	RBT
1	Explain Multi plate clutch with a neat sketch						[10]		CO2	L2
2	Explain hotch kiss drive and torque tube drive with neat sketches						[10]		CO2	L2
3	Explain working of Master cylinder of a braking system with a neat sketch						[10]		CO2	L2
4	Explain ABS with a neat sketch						[10]		CO2	L2
5	Explain the following terms with a neat sketch (a) Camber (b) Kingpin inclination (c) scrub radius (d) Included angle (e) castor						[10]		CO3	L2
6.	Explain Mec-pherson strut suspension system with a neat sketch						[10]		CO3	L2

USN



Internal Assessment Test 3 – May 2023

Sub:	Automobile Engineering					Sub Code:	18ME824	Branch:	ME	
Date:	12/05/23	Duration:	90 min's	Max Marks:	50	Sem / Sec:	VIII/A&B		OBE	
<u>Answer any FIVE FULL Questions</u>								MARKS	CO	RBT
1	Explain Multi plate clutch with a neat sketch						[10]		CO2	L2
2	Explain hotch kiss drive and torque tube drive with neat sketches						[10]		CO2	L2
3	Explain working of Master cylinder of a braking system with a neat sketch						[10]		CO2	L2
4	Explain ABS with a neat sketch						[10]		CO2	L2
5	Explain the following terms with a neat sketch (a) Camber (b) Kingpin inclination (c) scrub radius (d) Included angle (e) castor						[10]		CO3	L2
6.	Explain Mec-pherson strut suspension system with a neat sketch						[10]		CO3	L2

Scheme Of Evaluation
Internal Assessment Test 3 – March 2023

Sub:	Automobile Engineering						Code:	18ME824	
Date:	12/05/2023	Duration:	90mins	Max Marks:	50	Sem:	VIII	Branch:	ME

Note: Answer Any Five Questions

Question #		Description	Marks Distribution		Max Marks
1	a)	Explain multi plate clutch with a neat sketch <ul style="list-style-type: none"> • Diagram • Explanation 	5 M 5 M	10 M	10 M
2	a)	Explain hotch kiss drive and torque tube drive with neat sketches <ul style="list-style-type: none"> • Diagram • Explanation 	5 M 5 M	10 M	10 M
3	a)	Explain working of Master cylinder of a braking system with a neat sketch <ul style="list-style-type: none"> • Diagram • Explanation 	6 M 4 M	10 M	10 M
4	a)	Explain ABS with a neat sketch. <ul style="list-style-type: none"> • Diagram • Explanation 	5 M 5 M	10 M	10 M
5	a)	Explain the following terms with a neat sketch (a) Camber (b) Kingpin inclination (c) scrub radius (d) Included angle (e) castor <ul style="list-style-type: none"> • Diagram • Explanation 	5 M 5 M	10 M	10 M
6	a)	Explain Mec-pherson strut suspension system with a neat sketch <ul style="list-style-type: none"> • Diagram • Explanation 	5 M 5 M	10 M	10 M

1. The construction or Main Parts of Multi-Plate clutch are:

- Flywheel
- Pressure plates
- Clutch hub or Inner hub
- Clutch Pedal
- Steel plates or Driven Plates
- Friction plates or drive plates and
- Clutch springs

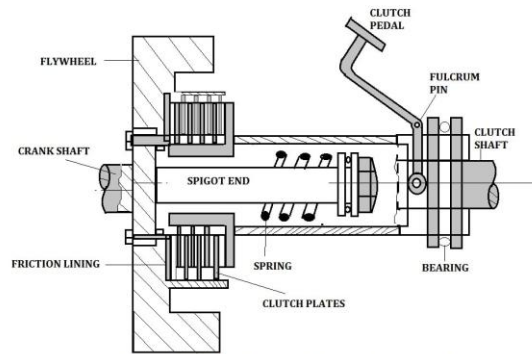


FIG: MULTI PLATE CLUTCH

Flywheel:

The flywheel is an important part of the engine and also a clutch system. The power transmission from the engine output shaft to the transmission shaft is obtained by the frictional contact between the clutch and the flywheel of the engine. It transmits generated power from one shaft to another shaft.

Pressure Plates:

The Pressure Plate is mounted on a splined shaft so that it can slide back and forth. The Friction discs are bolted to the pressure plate. Its sliding is controlled by the clutch pedal.

Clutch hub or Inner hub:

It is a rotating part attached to spline parts that provide torsional dampness. It has the pinion gear and the axle drive that is mounted on the axle housing and rested on the tapered bearings.

For this purpose, at least one plate is attached to the spline at a proper angle for the smooth functioning of the clutch.

Clutch Pedal:

A clutch pedal modulates or amplifies the clutch mechanism with help of a clutch pressure plate. Our foot will press the clutch pedal to engage and disengage the clutch with the help of the spring and pins mechanism. It pulls the pressure plate away from the clutch plate.

Steel plates or driven plates:

It is made up of non-corrosive steel material. The steel plates have the lugs or projection on the inner diameter that have the main function to control the power transmission of the input shaft.

It is the main part of the clutch that decides the functionality of the clutch. If the clutch overheats, the steel plates become discolored and it is a sign that it should be replaced.

Friction plates or drive plates:

A friction Clutch plate is used to transmit the input shaft and the engine at the same rotating speed. When the clutch is engaged friction plate is sandwiched between the flywheel and the pressure plate.

Friction should be sufficient so that there will be no slippage. mostly friction plate is made up of asbestos.

Clutch springs:

It is used to engage or disengage the clutch mechanism and store the torque energy and give back when required. Clutch springs are of two types coil clutch springs and tension clutch springs.

They are also used in clutch dampers to control the vibrations produced during engaging and disengaging.

Multi-Plate Clutch Working Principle:

In 2 wheeler vehicles as in bikes and scooters there is the problem of packaging due to that small size of them, So to get the required output, instead of a large single plate Clutch, A multi-plate Clutch having small clutch plates is used to transmit power between engine shaft and the transmission shaft.

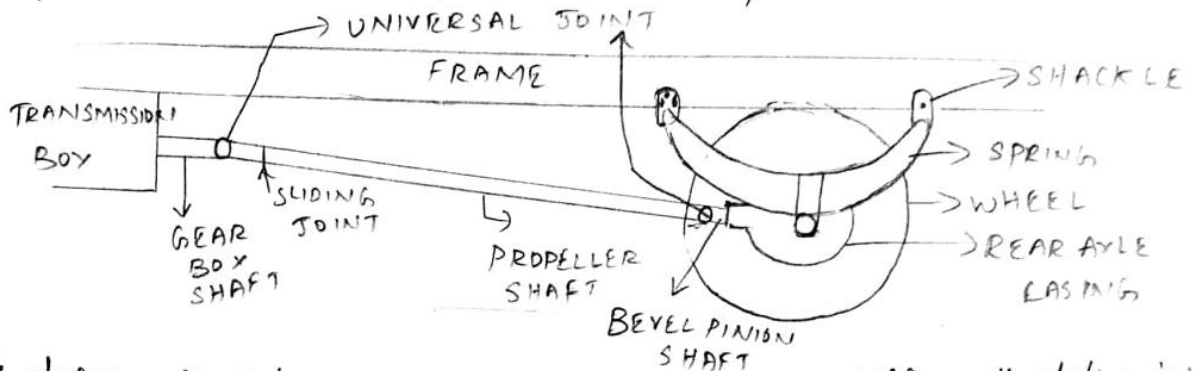
When there is the gradual Engagement of the clutch in order to transmit power between the Flywheel and the driven shaft multiple plates of multi-plate clutch provide more frictional force between the Flywheel and the pressure plate as compared to single plate clutch

Due to this, the chances of slip are almost zero or negligible in the multi-plate clutch which is helpful in getting a required mechanical advantage.

The two important types of rear axle drives are

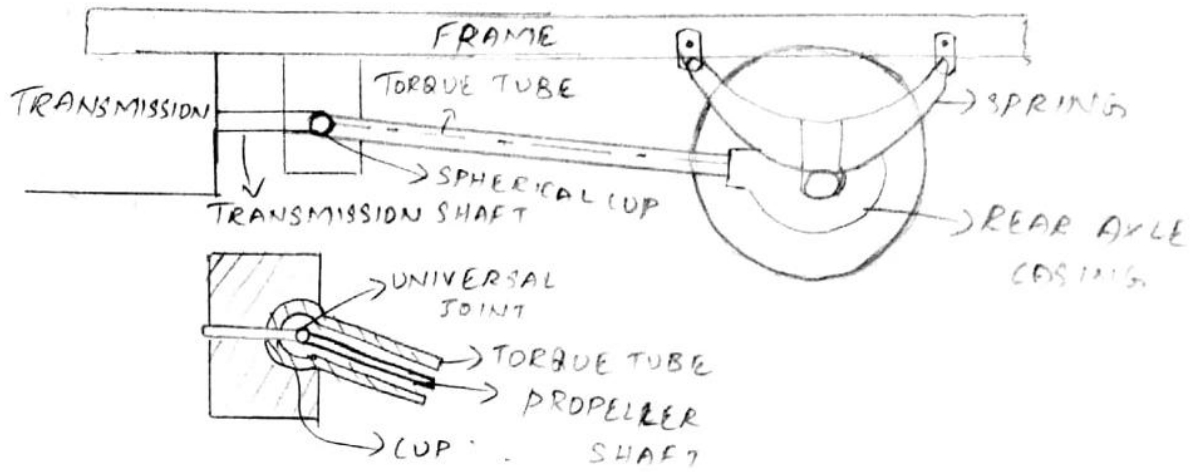
(i) Hotch kiss drive.

It is the most simple & widely used system. In this the springs besides taking weight of the body, also take the torque reaction, driving thrust & side forces.



The drive consists of open propeller shaft ~~shaft~~ with sliding joint & two universal joints one pinion shaft. The spring is bolted axle casing. The front end of the spring is rigidly fixed to the frame while the rear end is connected to the frame by swinging links or shackles. The front half of the spring will transmit the driving thrust to the frame. The springs offer considerable resistance to this deformation, thus torque reaction is overcome by the spring resistance to turn the axle casing. If universal joint is not provided in the rear end it will bend the propeller shaft because of axle casing movement the bevel pinion shaft tends to move up. The length of propeller shaft increases due to the movement of axle casing. So the sliding type propeller shaft is provided.

Torque tube drive :- In this case the springs take body weight & side thrust only. The torque reaction & the driving thrust is taken by the another member called Torque tube. Here the universal joints are replaced torque tube.

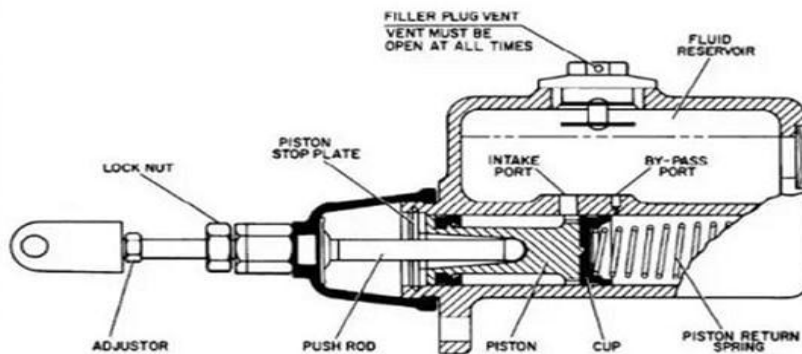


TORQUE TUBE DRIVE

These torque tubes are made tubular & usually surround the propeller shaft. One ^{end} of the torque tube is attached to the axle case while the other end which is spherical in shape fits in the cup fixed to the frame. As torque tube take torque reaction, the axis of bevel pinion shaft will not change & always pass through the centre of spherical cup if the universal joint is located exactly in the centre of spherical cup. And both pinion shaft & propeller shaft will move about the same centre i.e. about centre of spherical cup. Hence no sliding is required.

3. Parts or Construction of Master Cylinder

The master cylinder consists of various parts such as a pedal, reservoir, cylinder, pistons, return spring, valves, hose pipes, fluid check valve, and seals. These are further explained below:



Pedal:

This is the only part that can be controlled by the driver of the automobile. The driver uses the pedal to slow down or stop the vehicle according to the need.

The force exerted on the pedal by the driver has a direct effect on the master cylinder assembly. The brake pedal or lever is directly in contact with the master cylinder assembly.

Reservoir:

The reservoir is a storage that is used for storing the brake fluid. It is usually made up of plastic or fiber. The reservoir is connected to the cylinder via the inlet valve and supplies brake fluid into the system whenever required.

Brake fluids are viscous fluids used in hydraulic braking systems. The Brake fluids convert the force exerted on the brake pedal into pressure. They operate at high temperatures and pressures. These are graded just like the engine oil. The DOT series 1,2,3,4,5,5.1 are examples of the brake fluids used.

DOT stands for the department of transportation which has set standards for brake fluids. The DOT number is used to indicate the boiling point of the fluid. A higher DOT number indicates better quality and greater ability to withstand high temperature and performance environments.

DOT 3, 4, and 5.1 are glycol-based fluids while DOT 5 is silicone-based fluid. Glycol-based fluids are typically used in performance-based cars with ABS(anti-lock braking system). These are generally rectangular or square-shaped.

Cylinder:

The cylinder in the master cylinder assembly is an air-tight housing inside which the piston moves. It is the compression chamber in which the movement of the piston causes the brake fluid to be compressed at high pressure.

It is caused due to the moment of the brake pedal which in turn causes conversion and multiplication of force. It is usually made up of cast iron or aluminum.

The cylinder is connected to the reservoir through the inlet valve and brake liners through the outlet valve. The cylinder is an important component as it maintains high air pressure inside to keep the system operating without losses.

Single circuits consist of a single compression chamber and dual circuits have two compression cylinders with inlet and outlet valves for each.

Piston Assembly:

The piston assembly consists of a push rod and piston. The push rod is the part connected with the brake pedal and the piston.

When force is exerted on the brake pedal, it moves the pushrod to push against the piston. The piston is the reciprocating part inside the master cylinder that moves inside the cylinder when force is exerted by the movement of the brake pedal.

The piston is connected to a push rod which causes compression of the brake fluid inside the cylinder and generates higher hydraulic pressure on the brake calipers.

In a single circuit, only 1 piston is used and double circuits use 2 pistons (primary and secondary piston).

The primary piston is attached to the pushrod and the secondary piston is attached to the returning spring of the primary piston.

To prevent leakage of the brake fluid, rubber seals are present on either side of the piston. A rubber boot is used to cover the pushrod end of the cylinder to prevent the dirt from entering inside the brake lines.

Return Spring:

It is a simple coil-type spring that is used in drum and disc brakes. It helps the piston to return to its original position after the brake pedal is released. In a dual circuit system, two springs are used namely a primary spring and a secondary spring.

Valve:

It is the outlet valve that attaches the cylinder to the brake lines. The compressed brake fluid is transferred to the brake caliper through this valve. In a single circuit master cylinder, there is only one valve and a double circuit master cylinder consists of two valves (primary and secondary).

Fluid Check Valve:

It is also called the residual check valve. It is used to keep a certain amount of pressure inside the brake fluid line. This helps in the quick application of the brakes. Due to the fluid check valve, the brake pedal does not need to be pressed longer.

Seal/Cup:

The gap between the cylinder and piston is covered with the help of seals. The primary seal is attached at the spring side end of the piston and the secondary seal is attached on the opposite side.

The gap between the primary and secondary seal is filled with brake fluid by the inlet valve. The secondary seal prevents leakage of fluid behind the piston. A rubber boot is also used to prevent the entry of debris/contaminants into the master cylinder assembly.

How does Master Cylinder work?

Based on the number of cylinders used, the master cylinder can be classified into two sections:

Single Circuit:

In a single circuit master cylinder, when the brake pedal is in non actuated position, the piston remains at its original position which keeps the inlet valve of the reservoir closed due to which there is no incoming brake fluid from the reservoir to the compression chamber.

When the brake pedal is in the actuated position, the piston which is connected to the brake pedal through the connecting rod moves. This in turn opens the inlet valve due to which incoming brake fluid from the reservoir to the compression chamber takes place.

The brake fluid is compressed inside the compression chamber due to the movement of the piston inside the cylinder. The movement of the piston decreases the surface area for the brake fluid, thus increasing the pressure on the fluid.

After compression up to a certain pressure, the outlet valve opens and the compressed brake fluid is transferred to the brake caliper through the brake lines for further brake actuation.

Once the brake pedal is released, the wheel brakes are released and the pressure in the braking circuit falls. The piston returns to its neutral position which creates a vacuum, which opens the central valve and therefore ensures that brake fluid is replenished.

After the release procedure is complete, the non-actuated position is achieved and it opens the compensation valve which transfers the excess brake fluid in brake lines to the reservoir.

Double Circuit:

The working of the Double circuit master cylinder is almost similar to that of the single-cylinder master cylinder. The difference is the presence of two separate independent circuits of braking in the double circuit. When the brake pedal is in non actuated position, the piston remains at its original place, closing the inlet valve of both the compression chambers, which in turn cuts the incoming brake fluid from the reservoir to the compression chamber.

When the brake pedal is actuated, the primary piston moves due to which opening of the primary inlet valve takes place.

Due to the movement of the primary piston, compression of the brake fluid inside the primary chamber takes place.

After completion of the compression in the primary chamber, the primary outlet valve opens up and the compressed brake fluid is further sent to brake calipers through brake lines and actuation of the primary circuit brakes takes place.

Once the primary piston movement is complete i.e. at its extreme end, the secondary piston starts moving because of the force applied by the primary piston's spring which in turn opens the secondary valve.

The incoming of brake fluid from the secondary reservoir to the second compression chamber takes place.

The brake fluid from the secondary reservoir is then compressed and after complete compression, the secondary outlet opens up and this highly compressed fluid is sent to the brake calipers through brake lines and actuation of the secondary circuit brakes take place.

The returning mechanism of the piston after releasing the brakes in a dual cylinder is the same as that of a single cylinder.

Once the brake pedal is released, the wheel brakes are released and the pressure in the braking circuit falls. The piston returns to its neutral position which creates a vacuum, which opens the central valve and therefore ensures that brake fluid is replenished.

After the release procedure is complete, the non-actuated position is achieved and it opens the compensation valve which transfers the excess brake fluid in brake lines to the reservoir.

Advantages of Master Cylinder:

- The hydraulic braking in the master cylinder requires less effort from the driver for braking and the brake pedal does not need to be pressed for a long time for braking.
- The instantaneous movement of brake fluids inside the cylinder provides a quick braking effect on the wheels of the vehicle.
- In a dual cylinder arrangement, even if one brake line fails the other brake line will provide enough braking power.
- The braking pressure on each wheel is equal and does not have a pressure bias.
- The use of brake fluid overcomes the excess heat issue inside the braking system.

Disadvantages of Master Cylinder:

A leakage in the cylinder or pipeline can affect the performance of the master cylinder braking system.

- Contaminants or residues in the brake fluid can affect the performance of the system.
- Below-par levels of brake fluid levels can damage the parts of the system.
- Periodic change of brake fluid is necessary for optimum working.
- Bleeding of the brake fluid is necessary while filling to avoid the formation of air bubbles in the pipeline.
- The system will stop working if the hydraulic pressure inside the cylinder is lost.
- If the cylinder malfunctions, the brake will behave abnormally and pressure will not get distributed properly.

4. **Anti-lock Braking System** also known as anti-skid braking system (ABS) is an automobile safety system which prevents the locking of wheels during braking and avoid uncontrolled skidding. The modern abs system allows steering during braking which gives more control over the vehicle in case of sudden braking. The main advantages of using ABS system in vehicle is that it provides better control over the vehicle and decreases stopping distance on dry and slippery surfaces. Since in ABS installed vehicle the chance of skidding is very less and hence it provides a better steering control during braking. Without ABS system, even a professional driver can fail to prevent the skidding of the vehicle on dry and slippery surfaces during sudden braking. But with ABS system, a normal person can easily prevent the skidding of the vehicle and get better steering control during braking.

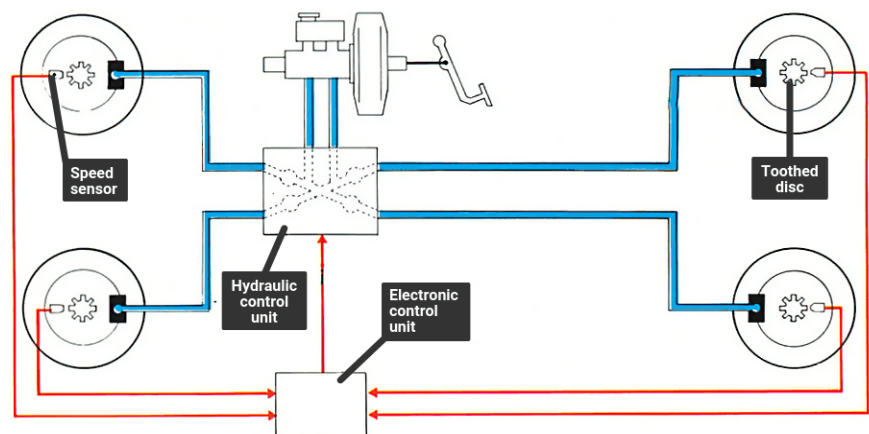
Principle of Working

It works on the principle of threshold braking and cadence braking. Cadence braking and threshold braking is a technique in which a driver applies the brakes and releases it before locking up the wheel and then applies the brakes and releases it again before locking. This process of applying and releasing the brakes on the wheel is done in pulse form to prevent it from locking and stop skidding of the vehicle. The driver practices this technique to achieve better control over the vehicle during instant braking and stop skidding of the vehicle. The ABS system automatically does this cadence braking to prevent locking of wheel and skidding of vehicle when brakes are applied.

Main Components of ABS System

It has four main components

1. speed sensors
2. Valves
3. Pump
4. Controller



1. Speed Sensors

It is used to calculate the acceleration and deceleration of the wheel. It consists of a toothed wheel and an electromagnetic coil or a magnet and a Hall Effect sensor to generate signal. When the wheel or differentials of the vehicle rotates, it induces magnetic field around the sensor. The fluctuation in this magnetic field generates voltage in the sensor. This voltage generated sends signals to the controller. With the help of the voltage the controller reads the acceleration and deceleration of the wheel.

2. Valves

Each brake line which is controlled by the ABS has a valve. In some of the systems, the valve works on three positions.

1. **In position one**, the valve remains open; and pressure from the master cylinder passed through it to the brake.
2. **In position two**, the valve blocks the line and separates the brake from the master cylinder. And this prevents the further rise of the pressure to the brakes. Valve operates in second position when the driver applies the brake harder.
3. **In position three**, some of the pressure from the brake is released by the valve.

The clogging of the valve is the major problem in ABS. When the valve is clogged, it becomes difficult for the valve to open, close or change position. When the valve is in inoperable condition, it prevents the system from modulating the valves and controlling pressure to the brakes.

3. Pump

Pump is used to restore the pressure to the hydraulic brakes after the valve releases the pressure. When the controller detects wheel slip, it sends signals to release the valve. After the valve releases the pressure supplied from the driver, it restore a desired amount of pressure to the braking system. The controller modulates (adjust) the status of the pump so as to provide desired amount of pressure and reduce slipping of the wheel.

4. Controller

The controller used in the ABS system is of ECU type. Its main function is to receives information from each individual wheel speed sensors and if a wheel loses its traction with the ground, a signal is sent to the controller, the controller than limit the brake force (EBD) and activate the ABS modulator. The activated ABS modulator actuates the braking valves on and off and varies the pressure to the brakes.

Working of Anti-lock Braking System (ABS)

- The controller (ECU-Electronic Control Unit) reads the signal from each of the speed sensors of the wheel.
- As the brakes are suddenly applied by the driver, this makes the wheel to decelerate at faster rate and may cause the wheel to Lock.
- As the ECU reads the signal which indicates the rapid decrease in the speed of the wheel, it sends signal to the valve which makes the valve close and the pressure to the brake pad reduces and prevents the wheel from locking.
- The wheel again starts to accelerate, again the signal sends to the controller, this time it opens the valve, increasing the pressure to the brake pad and brakes are applied, this again reduces the speed of the wheel and tries to make it stop.
- This process of applying brakes and releasing it happens 15 times in a second when a driver suddenly applies the brake harder. Due to this the locking of the wheel is prevented and the skidding of the vehicle eliminated. During braking with ABS system, the driver can steer the vehicle and reduces the risk of vehicle collision.

Advantages

1. It prevents the locking of the wheel and thus eliminates the chance of skidding.
2. The skidding of the vehicle is completely removed, which results in excellent control during braking?

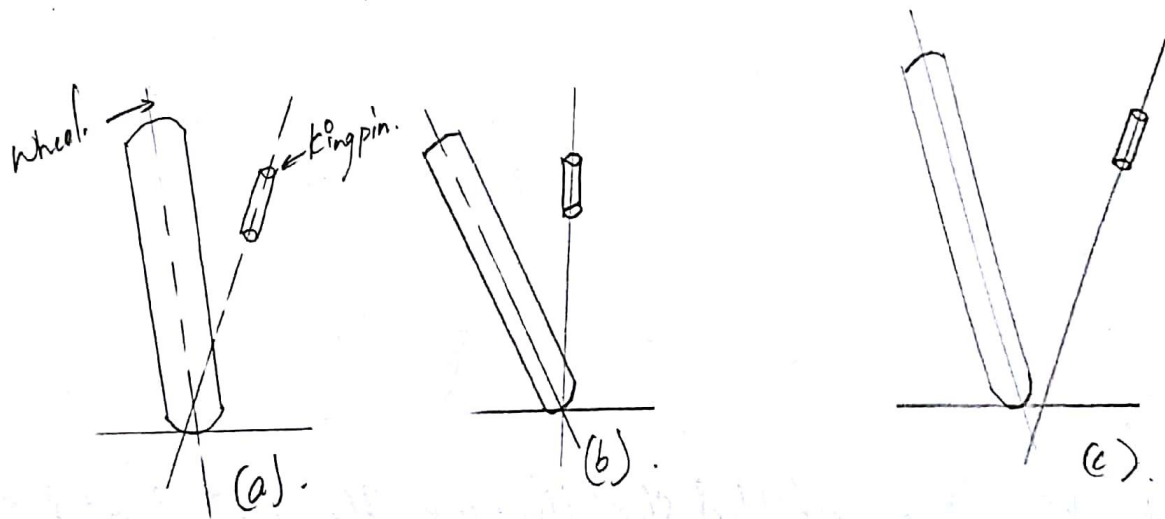
3. A better steering control is obtained with the ABS system.
4. It reduces the chance of collision by 30 %.

Disadvantages

A vehicle equipped with ABS (Anti-lock Braking System) is costlier as compared with a vehicle without ABS.

5 King pin angle.

The king pin (or) Ball joints are mounted in such a way that they slant inward. The king pin inclination is the inward tilt of the king pin (or) ball joint centre line from the vertical. In case of king pin it is called king pin angle in case of ball joint it is called as steering axis inclination. Included angle & scrub radius.

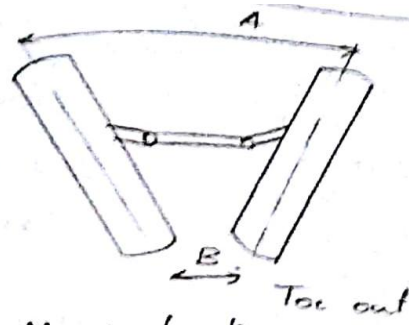
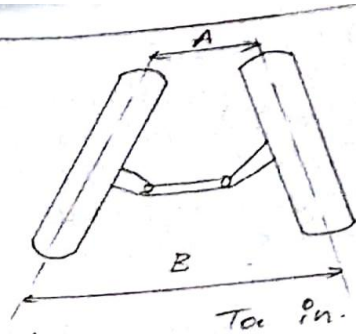


The wheel & king pin centre line meet (a) above the ground. wheels toe in (b) & exactly on the ground (c) Below the ground. wheel toe out.

It is the angle obtained in the vertical plane, b/w the wheel centre line & the king pin inclination ($X+Y$)

The distance b/w the king pin centre line & wheel centre line where it meets the road surface is called scrub radius.

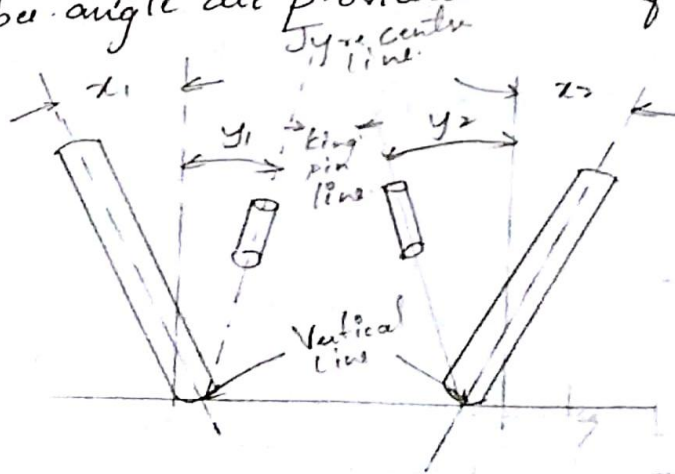
A negative scrub radius causes the wheel to toe in (a).
A positive scrub radius causes the wheel to toe out (b).



Camber.

Camber angle is the inclination b/w the centre line of the tyre & the vertical. If the wheels are inclined or tilted outward at the top it is called positive camber & if the wheels are inclined inward at the top it is called negative camber. It is also called as wheel rate angle.

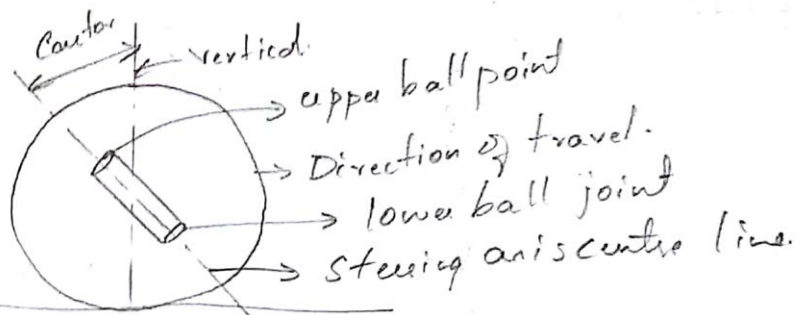
To make the tyre wear more uniform & increase the life of the tyre camber angle are provided to the front wheels.



Castor

The king pins are tilted slightly from the vertical obtained in the plane b/w king pin centre line & vertical is called the castor angle. If the king pin centre line contacts the ground at a point in front of the wheel centre line it is called positive castor. If it meets behind the wheel centre line it is called negative castor. The castor angle should not exceed 3 degrees.

It gives directional stability by making the wheels to lead or angle follow in the same direction as the vehicle moves.



6

The Mac-pherson strut is a type of car suspension system which uses the axis of a telescopic damper as the upper steering pivot.

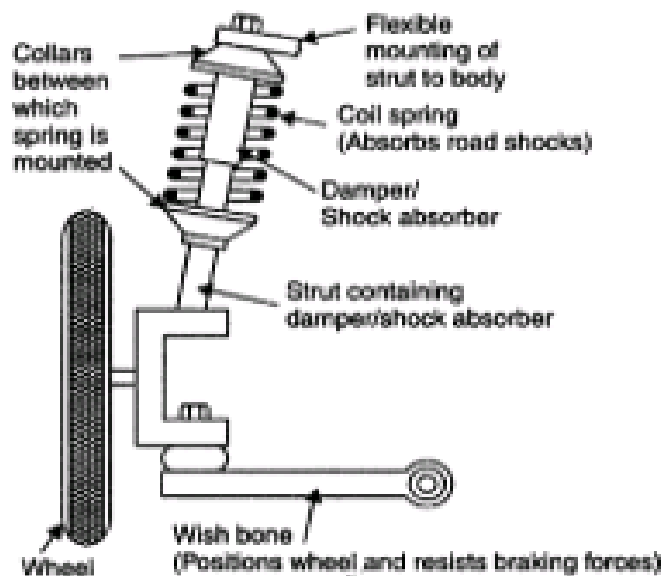
- It is widely used in modern vehicles and named after Earle S. Mac-pherson, who developed the design.
- Mac-pherson struts consist of a wishbone or a substantial compression link stabilized by a secondary link which provides a bottom mounting point for the hub or axle of the wheel. This lower arm system provides both lateral and longitudinal location of the wheel.
- The upper part of the hub is rigidly fixed to the inner part of the strut, the outer part of which extends upwards directly to a mounting in the chassis of the vehicle.
- The wishbone is hinged to the cross member and resists accelerating, braking and side forces.

Advantages:

- Simple design
- Low manufacturing cost
- It is lighter than double wishbone type and hence unsprung weight is lower.
- It gives maximum room in the engine compartment and hence generally used in FWD vehicles.

Disadvantages:

- It requires substantial vertical space and a strong top mount.
- Geometric analysis shows it cannot allow vertical movement of the wheel without some degree of either camber angle change, sideways movement, or both.
- It is not generally considered to give as good handling as a double wishbone or multi-link suspension, because it allows the engineers less freedom to choose camber change and roll centre.
- It tends to transmit noise and vibration from the road directly into the body shell, giving higher noise levels and a "harsh" feeling to the ride compared with double wishbones.



Mac-pherson strut Suspension