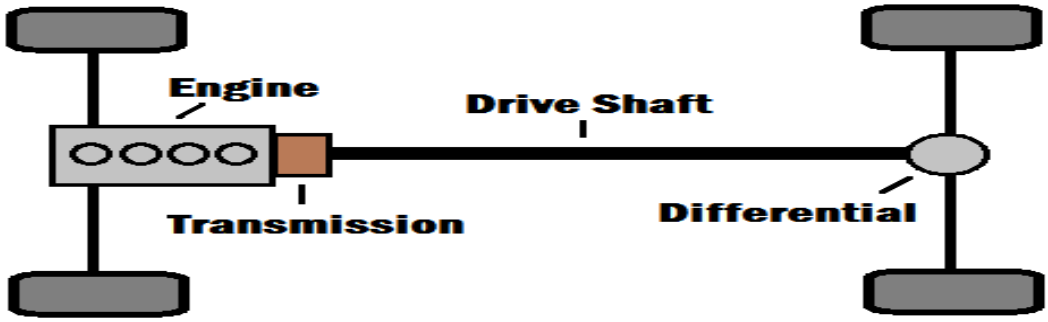
MODULE 2

DRIVE LINE COMPONENTS

DRIVELINE

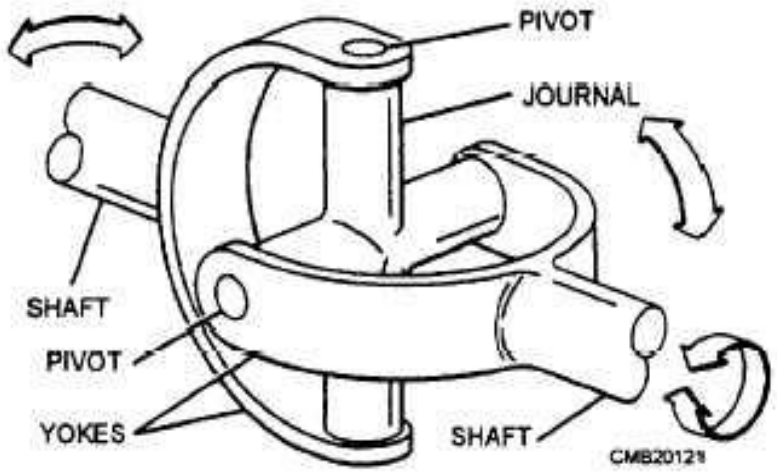
Drivelines are used on RWD vehicles and 4WD vehicles. They connect the output shaft of the transmission to the final gears in the rear axle housing. They are also used to connect the output shaft to the front and rear drive axles on a 4WD vehicle. A driveline consists of a hollow drive or propeller shaft that is connected to the transmission and drive axle by universal joints (U-joints). These U-joints allow the drive shaft to move with the movement of the rear suspension, preventing damage to the shaft.



UNIVERSAL JOINTS

Universal joints (U-joints) are used at both ends of a driveshaft. U-joints allow the wheels and the rear axle to move up and down, remain flexible, and still transfer torque to the drive wheels. A simple universal joint can be made from two Y-shaped yokes connected by a crossmember called a cross or spider.

If only one U-joint were used in a driveline, this change in speed of the driven side (output end) would generate vibrations in the driveline. To help reduce vibration, another U-joint is used at the other end of the driveshaft. If the angles of both joints are nearly equal, the acceleration and deceleration of one joint is offset by the alternate deceleration and acceleration of the second joint. It is very important that both U-joints operate at about the same angle to prevent excessive driveline vibration.



UNIVERSAL JOINT

CONSTANT VELOCITY JOINTS

Constant velocity joints, commonly called CV joints, are designed to rotate without changing speed. Regular U-joints are usually designed to work up to 12 degrees of angularity. If two Cardan-style U-joints are joined together, the angle at which this double-Cardan joint can function is about 18 to 20 degrees. Double-Cardan U-joints were first used on large rear- wheeldrive vehicles to help reduce drive-line-induced vibrations, especially when the rear of the vehicle was fully loaded and driveshaft angles were at their greatest. As long as a U-joint (either single or double Cardan) operates in a straight line, the driven shaft will rotate at the same constant speed (velocity) as the driving shaft. As the angle increases, the driven shaft speed or velocity varies during each revolution. This produces pulsations and a noticeable vibration or surge. The higher the shaft speed and the greater the angle of the joint, the greater the pulsations.

OUTER CV JOINTS

The Rzeppa-type CV joint is most commonly used as an outer joint on most front-wheel-drive vehicles. The outer joint must do the following

1. Allow up to 40 degrees or more of movement to allow the front wheels to turn

2. Allow the front wheels to move up and down through normal suspension travel in order to provide a smooth ride over rough surfaces

3. Be able to transmit engine torque to drive the front wheels

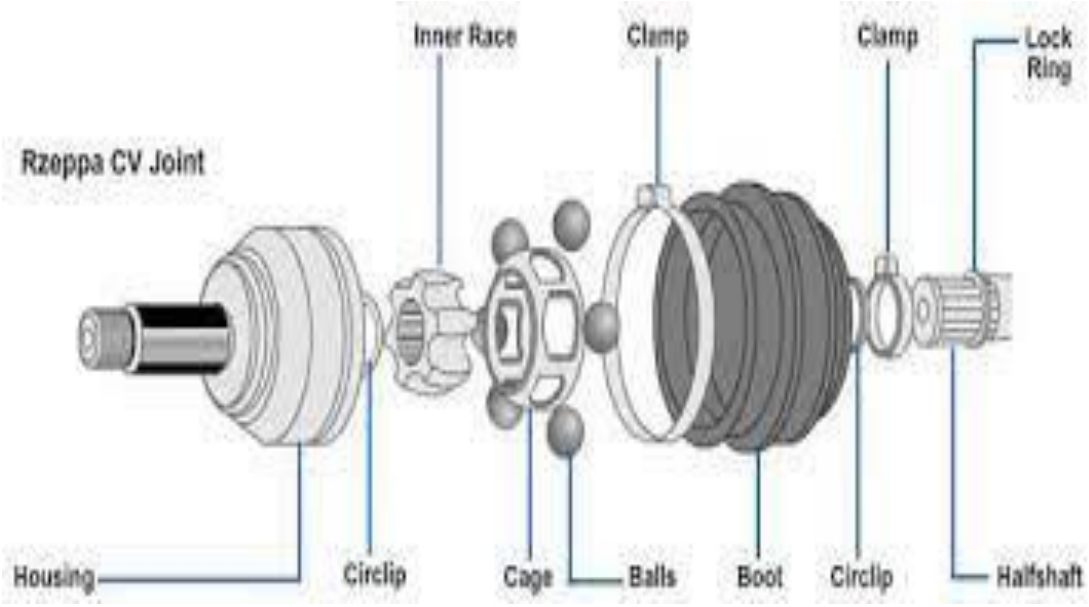
Outer CV joints are called fixed joints. The outer joints are also attached to the front wheels. They are more likely to suffer from road hazards that often can cut through the protective outer flexible boot.

INNER CV JOINTS

Inner CV joints attach the output of the transaxle to the drive axle shaft. Inner CV joints are therefore inboard, or toward the center of the vehicle. Inner CV joints have to be able to perform two very important movements:

1. Allow the drive axle shaft to move up and down as the wheels travel over bumps.

2. Allow the drive axle shaft to change length as required during vehicle suspension travel movements (lengthening and shortening as the vehicle moves up and down; same as the slip yoke on a conventional RWD driveshaft). CV joints are also called plunge joints.



DRIVE AXLE SHAFTS

Unequal-length drive axle shafts (also called half shafts) result in unequal drive axle shaft angles to the front drive wheels .This unequal angle often results in a pull on the steering wheel during acceleration. This pulling to one side during acceleration due to unequal engine torque being applied to the front drive wheels is called torque steer. To help reduce the effect of torque steer, some vehicles are manufactured with an intermediate shaft that results in equal drive axle shaft angles. Both designs use fixed outer CV joints with plunge-type inner joints.

DRIVE SHAFT

DIFFERENTIAL PARTS AND OPERATION

The differential allows engine torque to be applied to both drive axles, which rotate at varying speeds during cornering and while traveling over bumps and dips in the road. The differential also changes the direction of engine torque 90° from the rotation of the driveshaft lengthwise with the vehicle. A differential is a mechanical addition and subtraction assembly. By splitting the engine torque to the drive wheels when the vehicle is turning a corner, the torque forces cause the side gear and pinion gears to subtract torque from one side and add torque to the opposite side.

PARTS AND FUNCTION

While a vehicle travels straight ahead, the speed of each driven wheel must be allowed to vary slightly as they go over bumps, potholes, railroad tracks, and other road surface irregularities. While cornering, the wheels must be able to turn at much greater differences in speed. Without some mechanism to allow for a difference in speed between the wheels, the left wheel would skid through the turn. Inside the differential gear housing four to six bevel gears help drive the axles. In most differentials, there are two bevel gears called pinions that are constantly meshed with a beveled axle side gear on each axle. The pinion and axle side gears are contained in a housing called the carrier or case.

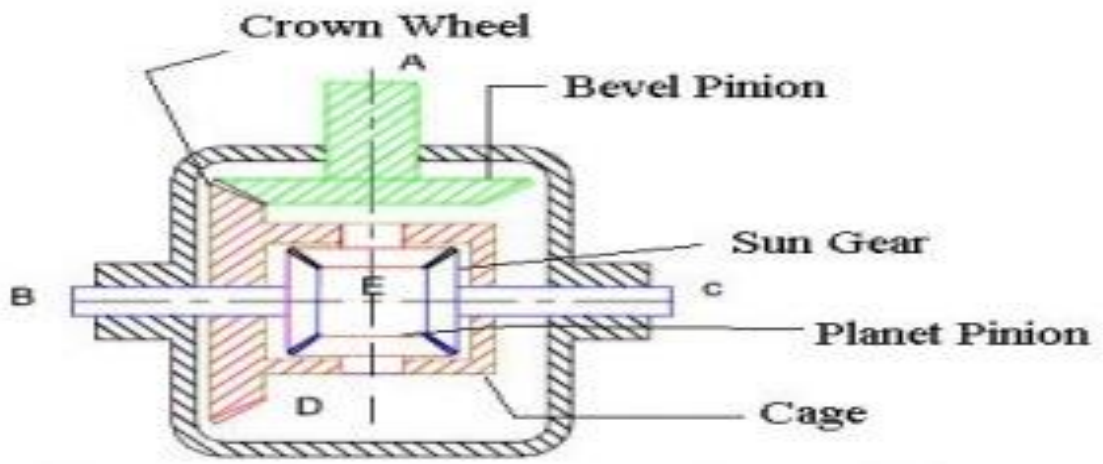


Fig: Differntial gear Assembly

LIMITED SLIP DIFFERENTIAL

When a vehicle equipped with a standard differential spins a tire, the opposite wheel does not receive enough torque to move the vehicle. To solve this problem, most manufacturers use differentials that direct more power to the side gear attached to the spinning axle. Many differentials do this by forcing the side gear against the revolving case. This bypasses differential action, allowing the case to drive the side gear directly. A limited-slip differential distributes torque to both wheels equally or unequally, allowing the wheels to turn at the same or at different speeds. he only means of having the standard differential apply different amounts of torque to each axle is to have the case drive the side gear directly, bypassing the pinion gears. One means of accomplishing this is to literally “push” the side gear out of mesh with the pinion gears against the rotating case.

FOUR WHEEL DRIVE SYSTEM

Two-wheel drive vehicles use engine torque to turn either the front or the rear wheels. A differential is required to allow the drive wheels to travel different distances and speeds while cornering or driving over bumps or dips in the road. A four-wheel-drive vehicle, therefore, requires two differentials—one for the front wheels and one for the rear wheels. Four-wheel-drive vehicles require more than just two differentials. The front and the rear wheels of a four-wheel-drive vehicle also travel different distances and speeds whenever cornering or running over dips or rises in the road. There are three different methods used to allow for front-to-rear driveline speed variation.

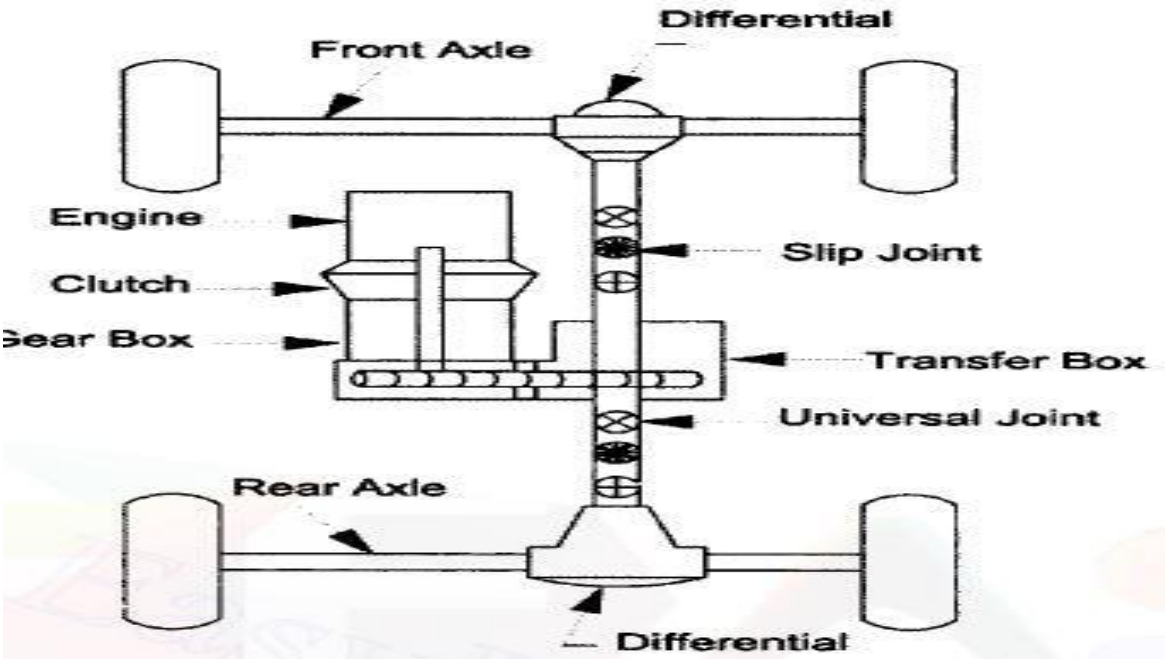


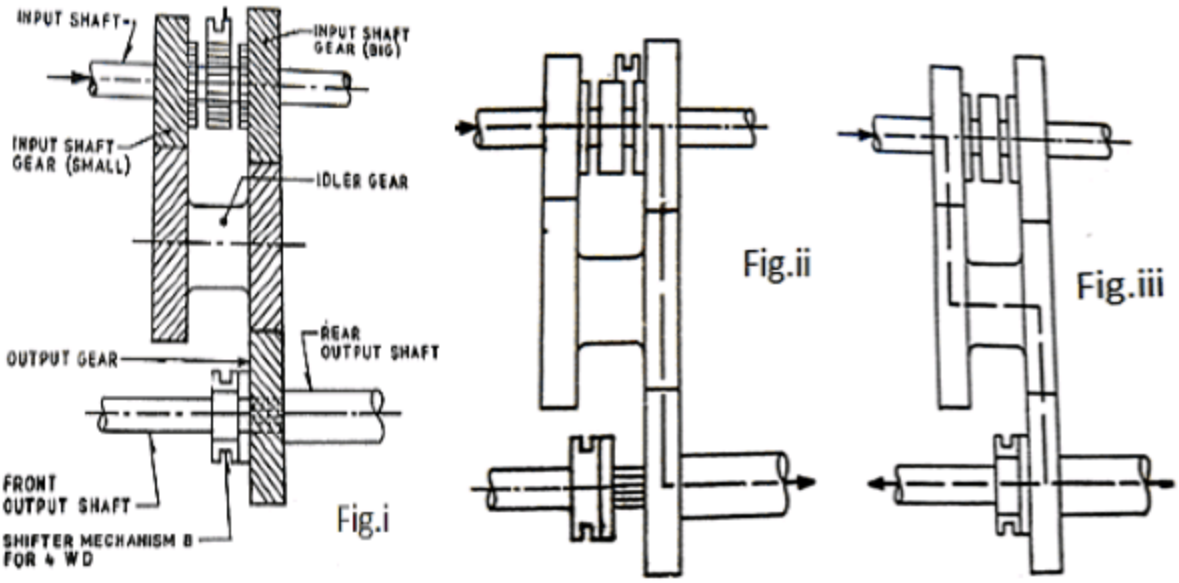
Figure 1.11 Four-wheel drive

ALL WHEEL DRIVE

Some cars and light trucks are equipped with an all-wheel-drive system that uses a transfer case with a center differential and only one speed (high). Low-range gear reduction is not used. A viscous coupling is usually incorporated into the center differential to provide superior all-weather traction. Combined with a limited-slip differential in the rear, and sometimes also in the front, an all-wheel-drive system can provide ideal road traction under all driving conditions without any action by the driver.

TRANSFER CASE

The purpose and function of the transfer case is to direct engine torque to the front and rear axle assemblies. A four-wheel-drive transfer case is basically an auxiliary 2-speed transmission. It uses the transmission output as an input to a secondary gear train or planetary gear set, which provides a low and high range. The transfer of torque to the front axle output shaft can be accomplished either by a gear-to-gear transfer or a gear and chain transfer. The gear ranges can be engaged a number of ways, such as a manual lever, electrical, or vacuum actuators. A transfer case has one input shaft (connected to the output of the transmission) and two output shafts. The two output shafts are connected to the driveshafts and transfer torque to the front and rear differentials.



Transfer Box

INTER-AXLE DIFFERENTIAL

All-the-time four-wheel-drive, all-wheel-drive, and full-time fourwheel-drive systems use an interaxle differential (center differential) to prevent driveline harshness and vibration, commonly referred to as driveline windup. An interaxle differential can be found in various configurations including: Standard bevel gear differential Planetary gear differential Viscous coupling Although they are different in appearance, interaxle differentials serve the same purpose, to maintain smooth operation while making turns in a four-wheel-drive/all-wheel-drive vehicle. The bevel gear differential uses two bevel gears or spider gears attached to the output shaft of the transmission. Two to four differential pinion gears are attached to a carrier, which is attached to the transfer gears. In other words, it operates in the same fashion as the differential in a ear axle; power is transferred to the tire with the least traction. When there is unequal traction between the front and rear axles, the axle with the most traction is allowed to slip enough to prevent damage to driveline components.

Functions/ Necessity of wheels

The power developed by the engine has been transferred through the clutch, gear box,

propeller shaft and differential to rear axles. Wheel is mounted on the hub of the rear axles.

Tyre tube assembly is mounted on a wheel. Tyres of Wheels are in contact with the road

surface. As the axle turns, the wheel also turns and the vehicle moves on the road due to

friction between tyres of wheels and road surface.

The wheel must be

1) Strong enough to withstand the weight of the vehicle

2) Flexible to absorb the road shock.

3) Able to grip the road surface.

4) Perfectly balanced.

5) Light in weight.

Types of wheels

1) Disc wheel
2) Wire wheel
3) Alloy wheel

Disc wheel

Fig shows a disc wheel. This type of wheel consists of steel rim and pressed steel disc. The rim is welded or riveted to the disc. The shape of rim is well type and the tyre tube assembly is mounted on the rim. The wheel assembly is bolted to the axle hub. The cap or cover is fitted to the disc by using spring claps. Holes are provided in the disc to allow the air inside for better cooling. A hole in the rim serves to accommodate the tube valve. The air is inflated into the tube through a tube valve.

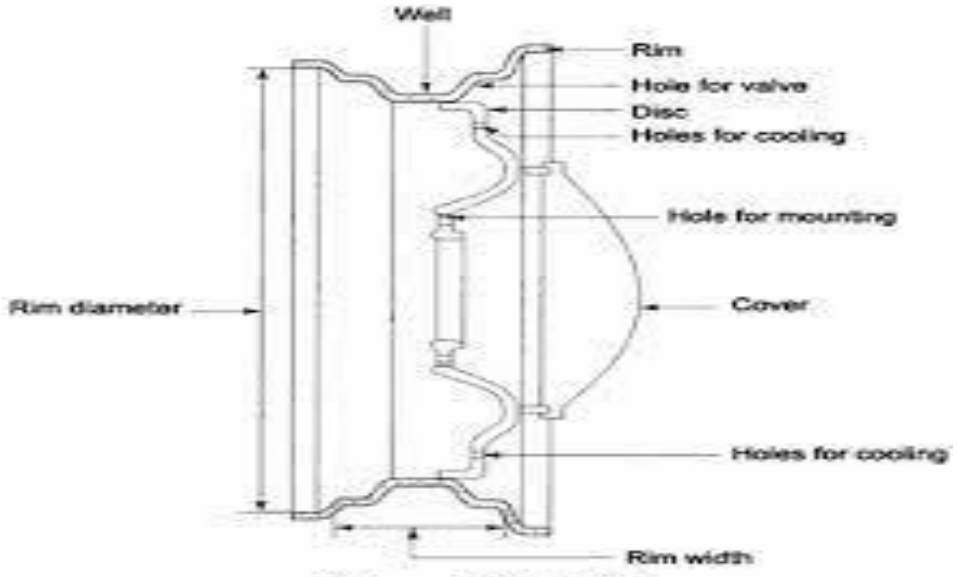


Fig. Disc wheel

Wire wheel

The wire wheel consists of rim, spokes and hub. The wheel rim is connected to the hub using the spokes. Each spoke is individually hooked at one end of the hub while the other end is pushed through a hole in the wheel rim, where a taper nut, called nipple, is screwed down pulling the spoke tight. The initial tension of the spoke is adjusted by screwing the nipples. The hub of the wheel has internal splines and is locked with external splines on the axle. The spokes are mounted in a complicated criss-cross fashion. The spokes arrangement shown in fig. a, transmits the driving torque from hub to wheel rim. The spokes arrangement shown I fig. b, transmits the braking torque from wheel rim to hub. The spokes arrangement shown in fig. c, sustain the vehicle weight. The spokes arrangement shown in fig. d, takes the side force while cornering.

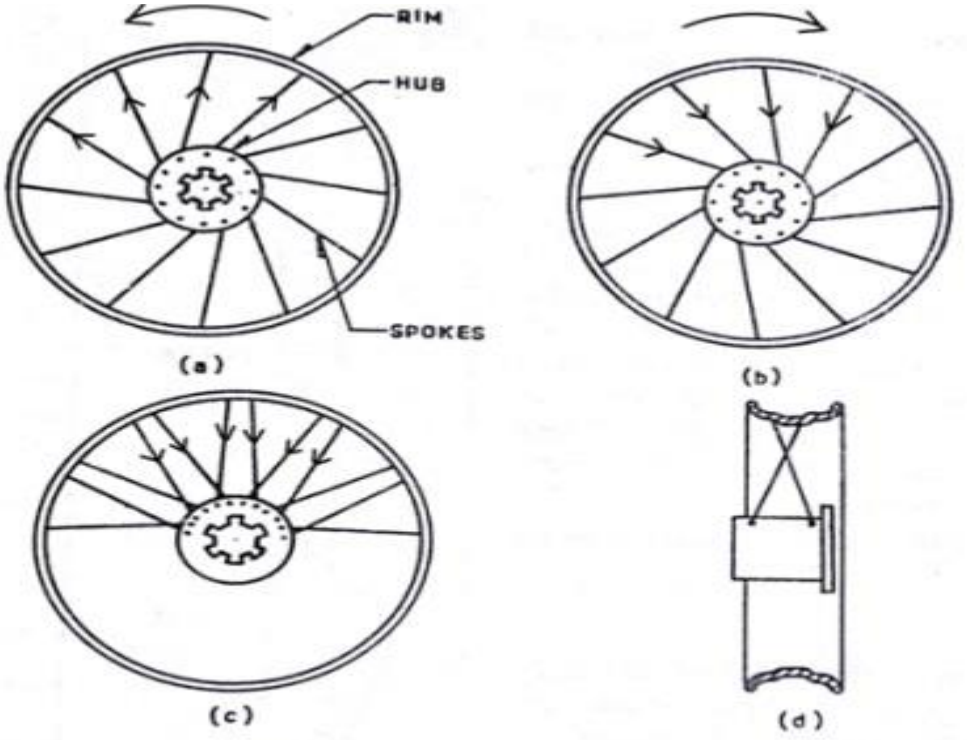


Fig. Taking stresses by spokes due to:
(*a*) driving torque, (*b*) braking torque,
(*c*) vehicle weight, (*d*) side force.

Alloy wheel

Forging or casting processes are used to manufacture the alloy wheel. The strength of the cast wheel is low hence it is used for cars and the strength of forged wheel is high hence it is used for heavier vehicles. Magnesium or aluminum is used for alloy wheels. Magnesium alloys have high impact and fatigue strength so that they can stand against vibration and shock loading better, but it is corrosive in nature, to avoid corrosion some protective cover is applied on magnesium alloy wheels. Aluminum alloys do not have high impact and fatigue strength but these are relatively easier to cast or forge and also less corrosive in nature. Aluminum alloys are used for wheels of cars, commercial vehicles, whereas sports and racing cars usually have magnesium alloy wheels.

Types of tyre

1) Conventional tubed tyre

2) Tubeless tyre

1) Conventional tubed tyre

In a tubed tyre, the tyre is mounted on the rim of the wheel. The air inflated rubber tube is kept in between the tyre and rim of the wheel. The main base material for tyre is rubber; other additives are used in rubber to increase the various properties of tyre.

a) Tread – the outermost portion of the tyre which comes in contact with the road surface is called tread. Since the tread portion comes in contact with the road surface, more wear is absorbed at the trade portion. wear is absorbed at the trade portion. Z`

b) Breakers – the first two plies just below the tread are known as breakers. The breakers

are widely spaced and it helps to break the road shocks.

c) Carcass or casing – the whole portion below the tread portion is called a carcass or

casing. The carcass consists of a number of plies wound in a particular fashion from

the cord of rayon or any other suitable material with rubber. Number of plies in the

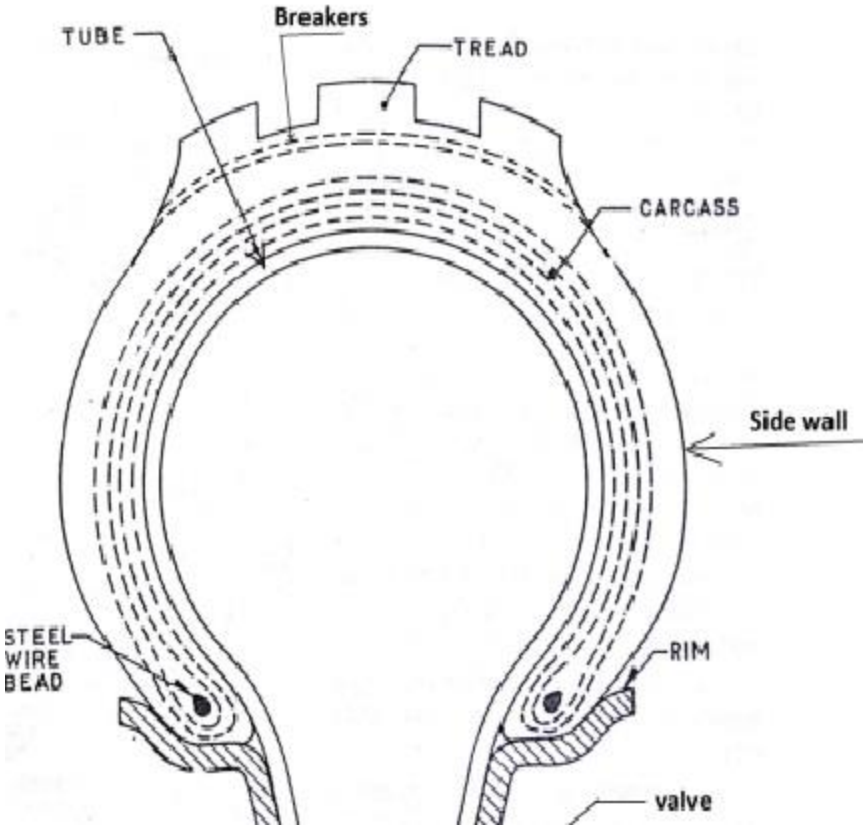
carcass depends upon the type of vehicle. Car tyres have 4 to 6 plies while heavy duty trucks have 20 to 24 plies. The more the number of plies, the more will be the strength and load carrying capacity.

d) Side wall – the side walls of the tyre are flexible enough to allow expansion and contraction.

e) Tube – air inflated rubber tube is kept inside the tyre. The air is inflated in the tube through a one way non return valve.

f) Steel wire beads – the bronze plated steel wires are used in steel wire beads. The steel wire beads firmly grips the rim of the wheel. All the plies are firmly tied to the steel wire beads.

g) Flippers – a rubber cover is provided on a steel wire bed to increase the gripping strength is known as flippers.



2) Tubeless tyre

he construction of tubeless tyre is almost same as that of conventional tubed tyre. Only in tubeless tyre there is no separate rubber tube inside the tyre. The tubeless tyre lined inside with soft rubber liner which forms airtight seal with rim. Since the inner liner is not stretched like the tube, it retains the air better which results slower air leakage when tyre gets punctured.

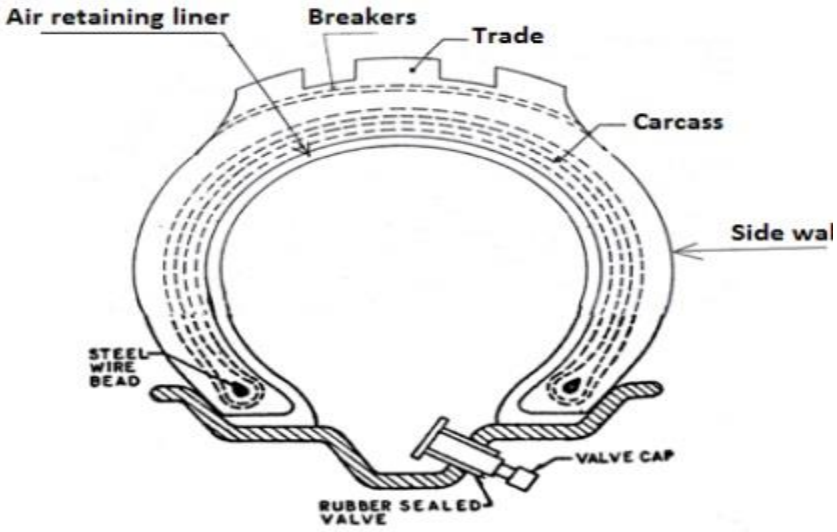


Fig. Section of Tubeless tyre

TREAD PATTERN

The outermost portion of the tyre which comes in contact with the road surface is called a tread. Since the tread portion comes in contact with the road surface, more wear is absorbed at the trade portion.

The desirable properties for the trade portion

- Abrasion and wear resistance.
- Heat resistance.
- Trade should give proper grip with the road surface.
- During the rainy season the water should be drained out quickly.

TIRE PRESSURE MONITOR

. A tire that is underinflated will have a slightly smaller rolling radius than one that is properly inflated. This will create a difference in the wheel speed sensor reading if the difference in inflation pressure is 12 PSI or more. The ABS controller will then turn on the low tire pressure warning lamp

to warn the driver that tires need attention. To help compensate for speed variation during cornering, an indirect tire pressure monitoring system checks the rotating speeds of diagonally opposed wheels. The system adds the speeds of the right front and left rear and then subtracts that value from the sum of the left front and right rear tires. If the total is less than or equal to a threshold value, no warning is given. However, if the total is greater than a predetermined value, the TPMS warning light is illuminated. The warning lamp will stay on until air is added to the tire and the ignition is cycled off and on.

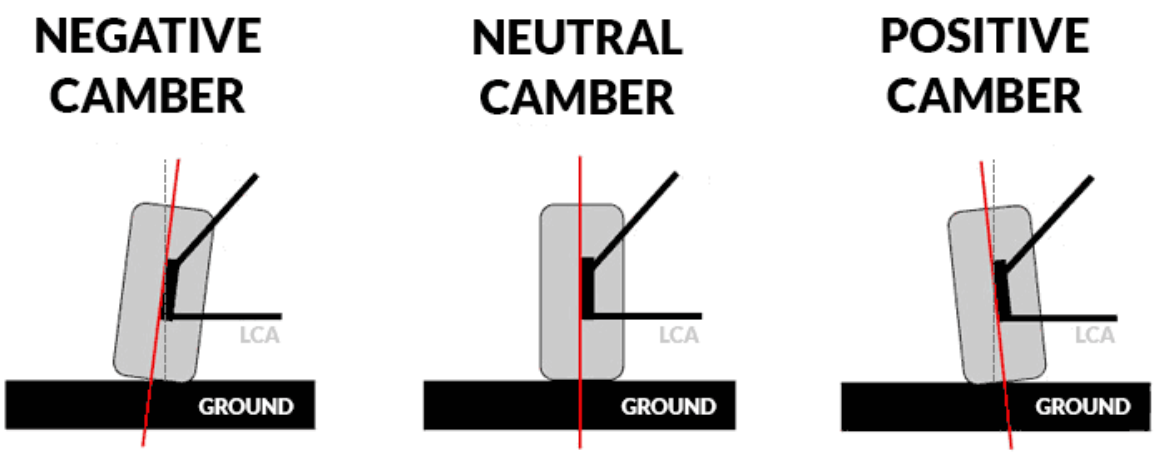
WHEEL ALIGNMENT GEOMETRY

A wheel alignment is the adjustment of the suspension and steering component angles to ensure proper vehicle handling with minimum tire wear. When a vehicle is new, the alignment angles are set at the factory. After many miles and/or months of driving, the alignment angles can change slightly.

CAMBER

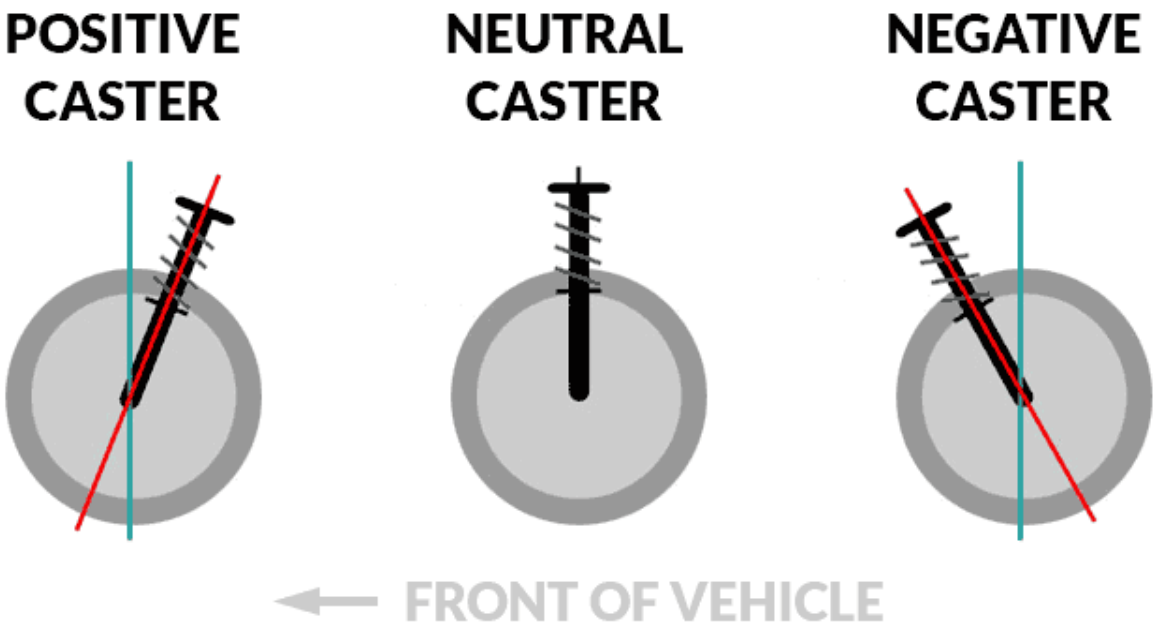
Camber is the inward or outward tilt of the wheels from true vertical as viewed from the front or rear of the vehicle.

If the top of the tire is tilted out, then camber is positive. If the top of the tire is tilted in, then camber is negative. Camber is measured in degrees or fractions of degrees. Camber can cause pull if it is unequal side-to-side. The vehicle will pull toward the side with the most positive camber. A difference of more than 1/2 degree from one side to the other will cause the vehicle to pull.



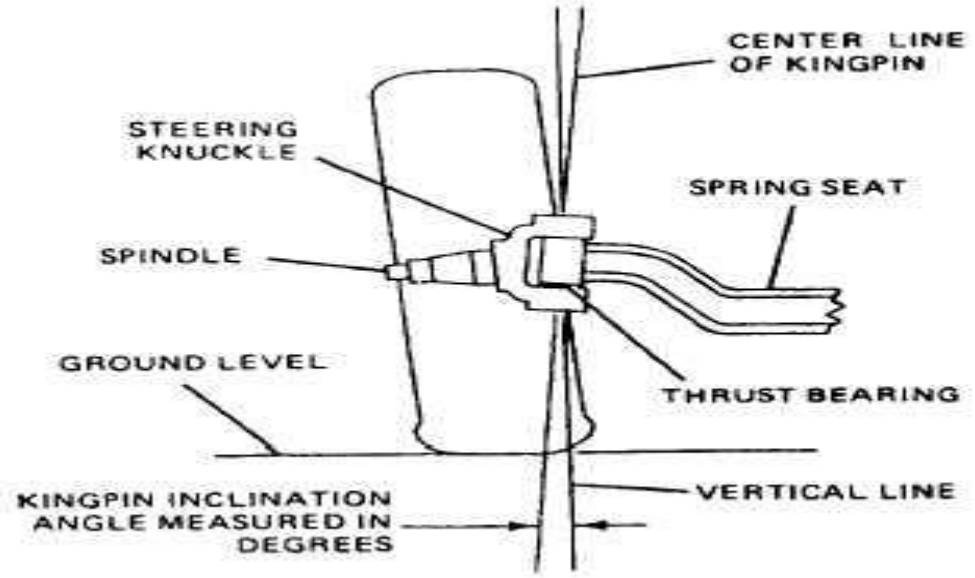
CASTOR

Caster is the forward or rearward tilt of the steering axis in reference to a vertical line as viewed from the side of the vehicle. The steering axis is defined as the line drawn through the upper and lower steering pivot points. On an SLA suspension system, the upper pivot is the upper ball joint and the lower pivot is the lower ball joint. On a MacPherson strut system, the upper pivot is the center of the upper bearing mount and the lower pivot point is the lower ball joint.



STEERING AXIS INCLINATION

The steering axis is the angle formed between true vertical and an imaginary line drawn between the upper and lower pivot points of the spindle. s the inward tilt of the steering axis. SAI is also known as kingpin inclination (KPI) and is the imaginary line drawn through the kingpin as viewed from the front. SAI is also called ball joint inclination (BJI), if SLA-type suspension is used, or MacPherson strut inclination (MSI).



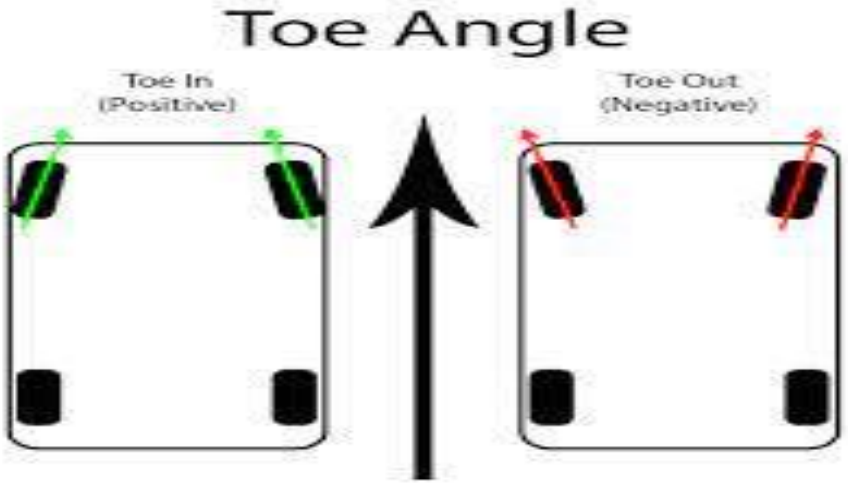
STEERING AXIS INCLINATION

TURNING RADIUS

Whenever a vehicle turns a corner, the inside wheel has to turn at a sharper angle than the outside wheel because the inside wheel has a shorter distance to travel. Turning radius is also called toe-out on turns, abbreviated TOT or TOOT, and is determined by the angle of the steering knuckle arms. Turning radius is a nonadjustable angle. The turning radius can and should be measured as part of an alignment to check if the steering arms are bent or damaged.

TOE IN AND OUT

Negative toe, or toe out, is the front of the wheel pointing away from the centreline of the vehicle. Positive toe, or toe in, is the front of the wheel pointing towards the centreline of the vehicle.


Toe Angle
Toe In
(Positive)
Toe Out
(Negative)