ZEAL Universal Motor Pvt. Ltd.

ATV Internship

Report

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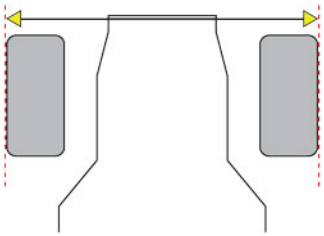
Introduction:

An ATV – All Terrain Vehicle that travels on low-pressure tires, with a seat that is straddled by the operator, along with handlebars for steering control. These ATVs are widely classified into 3 types namely: Sport, Utility, and Youth.

Track Width:

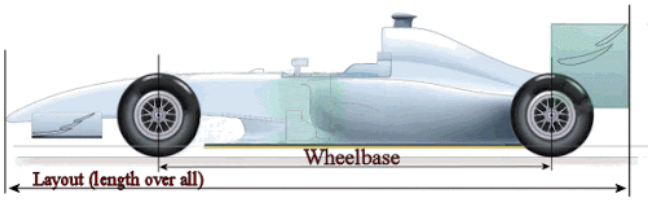
From the front view the distance between the two centers of planes of both the tires will give the track width of any vehicle.



Wheel Base:

From the side view the distance between the centers of the centers of the wheels will give the wheel base of a vehicle.

It is common that the track width in the front is larger than the rear for an ATV. Longer wheel base will ensure good stability and braking of the vehicle but will affect the steering power of the vehicle since the rear end is far away from the driver. The center of gravity will ensure that the car would not topple to either side during sharp turnings.



Tires and Wheels:

The tires and wheels are the major elemental factor to be considered while designing a ATV vehicle. In this the weight of the frame rim and the overall mass of the vehicle is to be considered so as to design a top-class vehicle. The wheels are connected with the help of the RIM. The disc is also attached to the vehicle in order to provide the stability in the brakes to drift the vehicle.

Normally in INDIA, 4'' GROUND CLEARENCE is maintained. The more the traction in the wheels, the more efficient the vehicle is.

Example: 185/60HR14

Rim Diameter: In this case it is 14 Section Width: In this case it is 185. The first number is the width of the tire in millimeters, measured from sidewall to sidewall. If your dimension is in inches, multiply by 25.4.

Suspension:

Suspension is the system of tires, tire air, springs, shock absorbers and linkages that connects a vehicle to its wheels and allows relative motion between the two. Suspension systems serve a dual purpose — contributing to the vehicle's roadholding/handling and braking for good active safety and driving pleasure, and keeping vehicle occupants comfortable and a ride quality reasonably well isolated from road noise, bumps, and vibrations. These goals are generally at odds, so the tuning of suspensions involves finding the right compromise. It is important for the suspension to keep the road wheel in contact with the road surface as much as possible, because all the road or ground forces acting on the vehicle do so through the contact patches of the tires. The suspension also protects the vehicle itself and any cargo or luggage from damage and wear. The design of front and rear suspension of a car may be different.

Types:

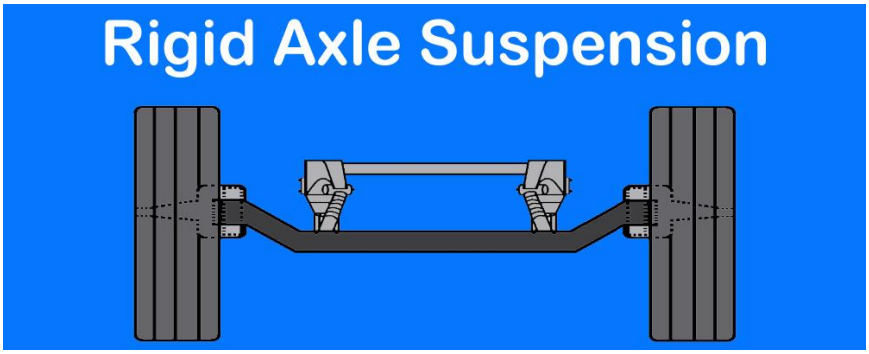
- ***Dependent***
- ***Independent***

Dependent:

Dependent systems may be differentiated by the system of linkages used to locate them, both longitudinally and transversely. Often both functions are combined in a set of linkages.

1. ***Rigid Axle:***

A beam axle, rigid axle or solid axle is a dependent suspension design, in which a set of wheels is connected laterally by a single beam or shaft. Beam axles were once commonly used at the rear wheels of a vehicle, but historically they have also been used as front axles in rear-wheel-drive vehicles. In most automobiles, beam axles have been replaced by front and rear independent suspensions.



2. Leaf Spring:

A leaf spring is a simple form of spring commonly used for the suspension in wheeled vehicles. Originally called a laminated or carriage spring, and sometimes referred to as a semi elliptical spring or cart spring, it is one of the oldest forms of springing, dating back to medieval times. Leaf spring on a German locomotive. A leaf spring takes the form of a slender arc-shaped length of spring steel of rectangular cross-section. The center of the arc provides location for the axle, while tie holes are provided at either end for attaching to the vehicle body. For very heavy vehicles, a leaf spring can be made from several leaves stacked on top of each other in several layers, often with progressively shorter leaves. Leaf springs can serve locating and to some extent damping as well as springing functions. While the interleaf friction provides a damping action, it is not well controlled and results in stiction in the motion of the suspension. For this reason, some manufacturers have used mono-leaf springs. A leaf spring can either be attached directly to the frame at both ends or attached directly at one end, usually the front, with the other end attached through a shackle, a short swinging arm. The shackle takes up the tendency of the leaf spring to elongate when compressed and thus makes for softer springiness. Some springs terminated in a concave end, called a spoon end (seldom used now), to carry a swiveling member.

Independent:

Independent suspension is a broad term for any automobile suspension system that allows each wheel on the same axle to move vertically (i.e., reacting to a bump in the road) independently of each other. This is contrasted with a beam axle or deDion axle system in which the wheels are linked – movement on one side effects the wheel on the other side. Note that "independent" refers to the motion or path of movement of the wheels/suspension. It is common for the left and right sides of the suspension to be connected with anti-

roll bars or other such mechanisms. The anti-roll bar ties the left and right suspension spring rates together but does not tie their motion together.

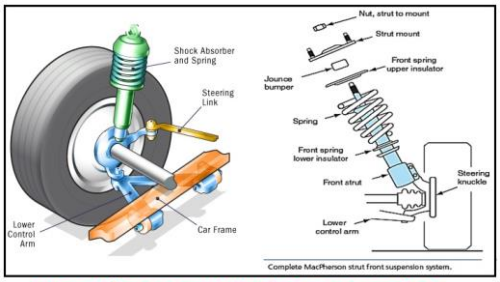
Most modern vehicles have independent front suspension (IFS). Many vehicles also have an independent rear suspension (IRS). IRS, as the name implies, has the rear wheels independently sprung. A fully independent suspension has an independent suspension on all wheels. Some early independent systems used swing axles, but modern systems use Chapman or MacPherson struts, trailing arms, multilink, or wishbones.

1. Double Wishbone:

In automobiles, a double wishbone (or upper and lower A-arm) suspension is an independent suspension design using two (occasionally parallel) wishbone-shaped arms to locate the wheel. Each wishbone or arm has two mounting points to the chassis and one joint at the knuckle. The shock absorber and coil spring mount to the wishbones to control vertical movement. Double wishbone designs allow the engineer to carefully control the motion of the wheel throughout suspension travel, controlling such parameters as camber angle, caster angle, toe pattern, roll center height, scrub radius, scuff and more.

2. MacPhearson Strut:

The MacPherson strut is a type of car suspension system which uses the top of a telescopic damper as the upper steering pivot. It is widely used in the front suspension of modern vehicles and is named for Earle S. MacPherson, who developed the design.



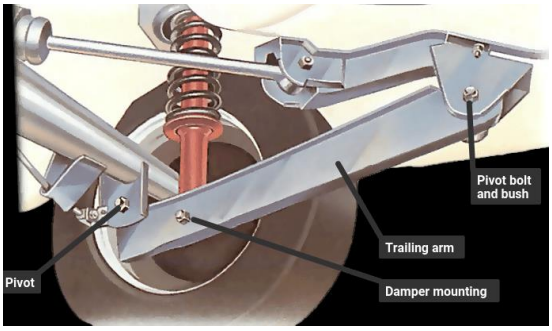
MacPherson Strut Suspension

3. Trailing Arm:

A trailing-arm suspension, sometimes referred as trailing-link is a vehicle suspension design in which one or more arms (or "links") are connected between (and perpendicular to and forward of) the axle and a pivot

point (located on the chassis of a motor vehicle). It is typically used on the rear axle of a motor vehicle. A leading arm, as used on the Citroën 2CV and the M422 Mighty Mite, has an arm connected between (and perpendicular to, and to the rear of) the axle and the chassis. It is used on the front axle. Trailing-arm designs in live axle setups often use just two or three links and a Panhard rod to locate the wheel laterally. A trailing arm design can also be used in an independent suspension arrangement. ϖ Each wheel hub is located only by a large, roughly triangular arm that pivots at one point, ahead of the wheel.

Seen from the side, this arm is roughly parallel to the ground, with the angle changing based on road irregularities. A twist-beam rear suspension is very similar except that the arms are connected by a beam, used to locate the wheels and which twists and has an anti-roll effect. A semi-trailing arm suspension is a supple independent rear suspension system for automobiles where each wheel hub is located only by a large, roughly triangular arm that pivots at two points. Viewed from the top, the line formed by the two pivots is somewhere between parallel and perpendicular to the car's longitudinal axis; it is generally parallel to the ground. Trailing-arm and multilink suspension designs are much more commonly used for the rear wheels of a vehicle where they can allow for a flatter floor and more cargo room. Many small, front-wheel drive vehicles feature a MacPherson strut front suspension and trailing-arm rear axle. Some aircraft also use trailing arms in their landing gear, with oleo struts for shock absorption. A trailing arm landing gear results in smoother landings and a better ride when taxiing compared to other types of landing gear.



Frame:

The objective of the study is to design and develop the roll cage for All - Terrain Vehicle. ϖ Material for the roll cage is selected based on strength, cost and availability. The roll cage is designed to incorporate all the automotive sub-systems. A software model is prepared in Solid works software. Later the design is tested against all modes of failure by conducting various simulations and stress analysis with the aid of Ansys Software. Based on the result obtained from these tests the design is modified accordingly. After successfully designing the roll cage, it is ready for fabricated. The vehicle is required to have a combination frame and roll cage consisting of steel members. As weight is critical in a vehicle powered by a small engine, a balance must be found between the strength and weight of the design. To best optimize this balance the use of solid modeling and finite element analysis (FEA) software is extremely useful in addition to conventional analysis. The following paper outlines the design and analysis of the roll cage design.

1. ***Design and Development:***

The design and development process of the roll cage involves various factors; namely material selection, frame design, cross-section determination and finite element analysis. One of the key design decision of our frame that greatly increases the safety, reliability and performance in any automobile design is material selection.

To ensure that the optimal material is chosen, extensive research was carried out and compared with materials from multiple categories. The key categories for comparison were strength, weight, and cost. The details of each step are given below.

2. Material Selection:

While the rules set many factors of the material 's geometry, there are many other limitations. These limitations include the method of fabrication and industry standards for the material. The frame will be built using a bent tube construction and MIG welded joints. MIG welding becomes difficult at wall thicknesses less than 0.035 inches. The tubing bender that will be used for the fabrication can bend a maximum of 1.5-inch diameter tube with a 0.120-inch wall thickness. It also requires that the tube have a minimum wall thickness of 0.055 inches. The geometry is also limited by industry standards. It is important to utilize commonly available tubing sizes and materials. Tubing is available in standard fractional sizes to the 1/8th of an inch: 1, 1.125, 1.25, 1.375, and 1.5. The wall thickness is limited to: 0.035, 0.049, 0.058, 0.065, and 0.083 inches. The most commonly available material for this type of tubing is ―ASTM 106 grade B Steel‖. The ASTM 106 grade B Steel has the same Modulus of Elasticity (E) and density as the mild steel, so using it does not affect the weight or stiffness in members with the same geometry. After a careful study, based on the properties and cost and availability criteria, it was found that the following material with its properties given should be used.

Density (x 1000 kg/m3) - 7.7 - 8.03, Poisson's ratio = 0.27- 0.30, Elastic Modulus (GPa) = 190 - 210 Tensile Strength (MPa) = 415, Yield Strength(MPa) = 240, Elongation (%) = 20 Reduction in Area (%) 48 Hardness (HRB) = 100

3. Frame Design:

To begin the initial design of the frame, some design guidelines were required to be set. They included intended transmission, steering and suspension systems and their placement, mounting of seat, design features and manufacturing methods. It is also required to keep a minimum clearance of 3 inches between the driver and the roll cage members. It is also necessary to keep weight of the roll cage as low as possible to achieve better acceleration. It is necessary to keep the center of gravity of the vehicle as low as possible to avoid toppling. Mounting heavier components such as engine, driver seat etc. directly on the chassis is one way of achieving low center of gravity. Also, it is imperative to maintain the integrity of the structure. This is done by providing bends instead of welds which in turn reduces the cost. A layout of the chassis within the given geometrical constraints.

4. Finite Element Analysis:

After finalizing the frame along with its material and cross section, it is very essential to test the rigidity and strength of the frame under severe conditions. The frame should be able to withstand the impact, torsion, roll over conditions and provide utmost safety to the driver without undergoing much deformation. Following tests were performed on the roll cage.

- Front Impact
- Side Impact
- Rear Impact

Types of Chassis:

There are three types of frames:

1. ***Conventional Frame:***

It has two long side members and 5 to 6 cross members joined together with the help of rivets and bolts. The frame sections are used generally:

Channel Section – Good resistance to bending

Tabular Section – Good resistance to Torsion

Box Section – Good resistance to both bending and Torsion

2. ***Integral Frame:***

This frame is used now a days in most of the cars. There is no frame and all the assembly units are attached to the body. All the functions of the frame carried out by the body itself. Due to elimination of long frame, it is cheaper and due to less weight most economical also. Only disadvantage is repairing is difficult.

3. ***Semi-Integral Frame:***

In some vehicle's half frame is fixed in the front end on which engine gear box and front suspension is mounted. It has the advantage when the vehicle is met with accident the front frame can be taken easily to replace the damaged chassis frame. This type of frame is used in some of the European and American cars.

Engines:

An engine, or motor, is a machine designed to convert one form of energy into mechanical energy. Heat engines, including internal combustion engines and external combustion engines (such as steam engines) burn a fuel to create heat, which then creates a force. Electric motors convert electrical energy into mechanical motion, pneumatic motors use compressed air and others—such as clockwork motors in wind-up toys— use elastic energy. In biological systems, molecular motors, like myosin's in muscles, use chemical energy to create forces and eventually motion.

Types:

- Two stroke engines
- Four stroke engines
- Jet engine

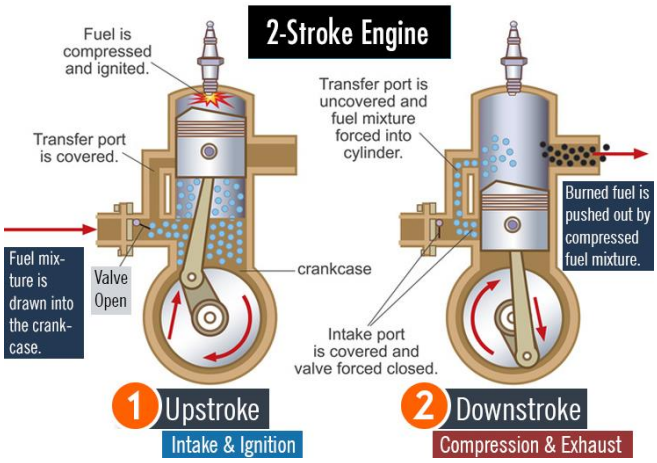
Engines are built with cylinders having no. of valves for inlet fuel and outlet exhaust, inside which the fuel burns along with air. The cylinders are made of super-strong metal and sealed very tightly, but at one end they open and close as they have tight fitting pistons that can slide up and down inside them. At the top of each cylinder, there are two valves. The inlet valve allows fuel and air to enter the cylinder from a carburetor or electronic fuel-injector; the outlet valve lets the exhaust gases escape. At the top of the cylinder, there is a spark plug, an electrically controlled device that makes a spark to set fire to the fuel. At the bottom of the cylinder, the piston is attached to a constantly turning axle called a crankshaft. The crankshaft powers the vehicle's driving system, which in turn drives the wheels.

The inlet and outlet valves are controlled by a chain system called timing chain. When both the inlet and outlet valves open simultaneously, it is referred as valve overlapping. It is always mandatory that the inlet valve is always bigger than the outlet valve. Bore is the centre part of the engine where the piston moves vertically.

The inlet valve must be approximately 45% of the bore diameter and the outlet value must be approximately 38% of the bore diameter. Sprockets are circular components which help to drive a chain by locking themselves into the chain. The activation of the inlet and outlet valves is done by the cam lobe. The shape of the piston is neither circular nor oval. It is a specially designed shape called 'ovality'.

Two Stroke Engines:

The two-stroke engine is a type of internal combustion engine which completes one power stroke in two strokes namely, the compression and the combustion stroke. The fuel intake and the exhaust happen at the same time. The fuel is taken from the inlet and combustion takes place when the spark plug ignites a spark. The exhaust is now let out and simultaneously the fuel intake for the next cycle is taken aside.



Two stroke engines have high power-to-torque ratio than the four stroke engines since they provide a power stroke in two cycles. These have merely less no. of moving parts and they don't have valves and hence they weigh less than the four stroke engines.

Four Stroke Engines:

A four-stroke engine is an internal combustion engine in which the piston completes four separate strokes which constitute a single thermodynamic cycle. A stroke refers to the full travel of the piston along the cylinder, in either direction. The four separate strokes are namely intake stroke, compression stroke, power stroke and exhaust stroke.

- ***Intake Stroke***: This stroke of the piston begins at top dead center (TDC). The piston falls from the top of the cylinder to the bottom of the cylinder, increasing the volume of the cylinder. A mixture of fuel and air is forced by atmospheric pressure or by some form of air pump pressure into the cylinder through the intake valve.
- ***Compression Stroke***: With both intake and exhaust valves closed, the piston returns to the top of the cylinder compressing the air or fuel-air mixture into the cylinder head.
- ***Power Stroke***: This is the start of the second revolution of the cycle. While the piston is close to Top Dead Centre, the compressed air–fuel mixture is ignited, by a spark plug inside the engine, or which ignites due to the heat generated by compression in a diesel engine. The resulting pressure from the combustion of the compressed fuel-air mixture forces the piston back down towards the bottom dead center (BDC).
- ***Exhaust Stroke***: During the exhaust stroke, the piston once again returns to top dead centre while the exhaust valve is open. This action expels the burnt fuel-air mixture through the exhaust valve or outlet valve.

Air Fuel In-take:

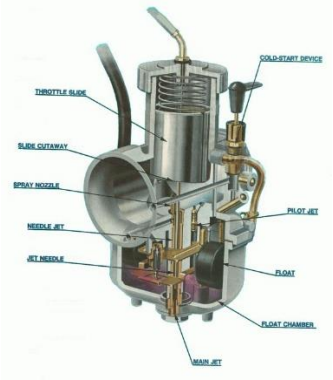
For the combustion to take place inside an engine, air containing oxygen must be present in it. Hence there are certain systems which help to blend air and fuel so that a complete combustion can be achieved easily and no unburnt fuel escapes. There are two main types:

1. Carburetor
2. Fuel injection

The value for the mixture of air and fuel is determined using the stoichiometric ratio. It gives the ratio of mixture of air to the amount of fuel. The standard ratio is approximately given around 14.7:1, where 14.7' is the ration of air present to 1'amount of gasoline or any liquid fuel.

Carburetor:

One of the common types is a carburetor type air-fuel intake. The carburetor works on Bernoulli's principle: the faster air moves, the lower its static pressure, and the higher its dynamic pressure. The throttle linkage is controlled by a Throttle Position Sensor (TPS) and it does not directly control the flow of liquid fuel. Instead, it actuates the flow of air being pulled into the engine. The speed of this flow, and therefore its pressure, determines the amount of fuel drawn into the airstream.

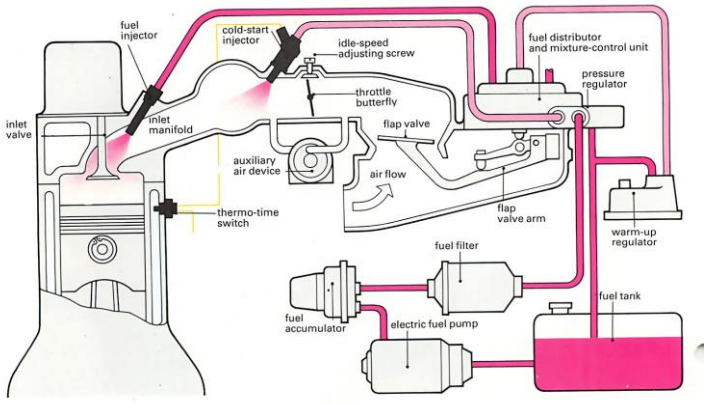


The carburetor consists of a butterfly valve which opens proportionally to the thrust from the throttle. This valve allows air mixture into the carburetor. Fuel is allowed from a fuel inlet. This inlet is controlled by a float system. A float is present inside the carburetor vessel which closes the inlet using jets. Jets are small needing like structured components which close the vents of the inlet when the required amount of fuel is acquired in the float bowl. The air and the fuel are mixed and sent to the cylinders for combustion.

Fuel Injection:

It is a latest method used in automobiles for air-fuel mixture intake, which have replaced the conventional carburetors from the late 20th century. In this method fuel is injected or sprayed into the air mixture which provides a complete blend of air and fuel for the combustion to take place.

The fuel injector is electronically controlled unlike carburetor which is mechanically controlled. The fuel injector is controlled by an Electronic Control Unit (ECU). The ECU instructs the injector about the amount of fuel to be injected, the speed of injection and the throttle response. The temperature of the piston and bore is monitored and controlled by a Temperature Sensor device.



Some of the benefits of fuel injection include more smoother and more consistent throttle response, such as during quick throttle transitions, easier cold starting, more accurate adjustment to varying temperatures and changes in air pressure, less maintenance, and better fuel efficiency.

Clutch Assembly:

A clutch is a mechanical device that is used to engage and disengage the power transmission, especially from driving shaft to drive shaft. The clutch assembly consists of a clutch plate, friction plates, pressure plates, springs, central hub, clutch lever or pedal etc. The whole clutch system is assembled entirely with frictional contact.

When the driver applies the clutch, the pressure plate loses friction and they tend to extend outwards which disengages the clutch plate from the flywheel as the frictional contact is lost and the acceleration to the wheels is stopped and the wheel starts to decelerate and stops at one point. Hence the speed of the vehicle can be controlled using the clutch system. There are some common types:

1. single plate
2. multi plate
3. centrifugal
4. Diaphragm

Brakes:

Brakes are mechanical devices which slow down, stop, and decelerate the motion of a moving object which is in dynamic motion. Brakes use the principle of friction which converts kinetic energy into heat. In commercial vehicles brakes are fitted to the wheels of the vehicle, in order to stop its motion.

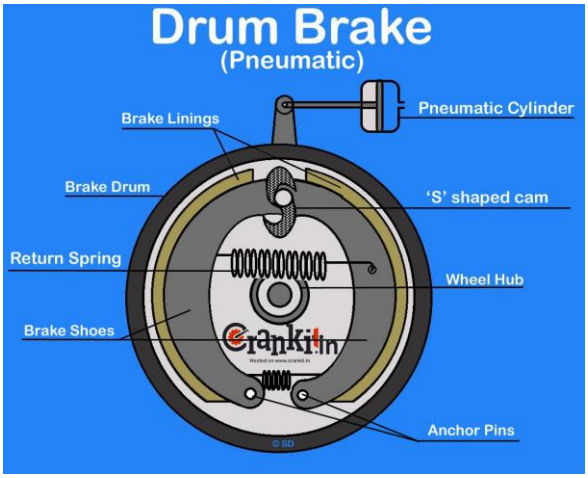
1. Drum brakes
2. Disc brakes

The main components of a brake system are master cylinder, calipers, rotor/disc, pads, pedal/ lever, hose line/ pressure line, etc. The master cylinder consists of a piston which exerts pressure on applying the brakes. Commonly, the master cylinder and the brake pedal are pivoted to a joint called fulcrum on the chassis of the vehicle.

When the brakes are applied, two processes take place one after the other. First a mechanical process followed by a hydraulic process. A pressure is applied on the master cylinder which pushes the piston inside by which the pressurized fluid leaves the cylinder. This fluid with high pressure reaches the rotor to which the pads of the brake are attached. This fluid pushes the pads accordingly so as to stop the rotation of the rotor.

Drum Break:

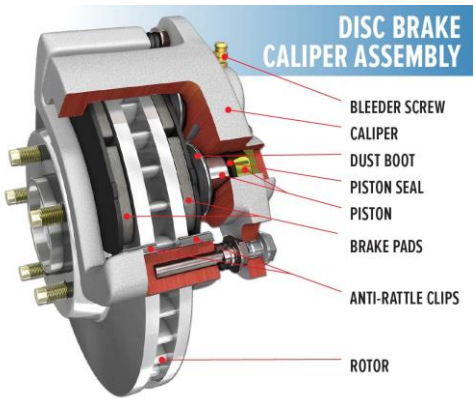
A brake that uses friction caused by a set of pads that press against a rotating rotor to stop the motion is called a brake drum. The term drum brake usually means a brake in which shoes press on the inner surface of the drum. When shoes press on the outside of the drum, it is usually called a clasp brake. Where the drum is pinched between two shoes, similar to a conventional disc brake, it is sometimes called a pinch drum brake. Drum brakes are one of the most widely used brakes for automobiles. Mostly these types of brakes use high tension springs to control the braking action. An emergency braking mode is enabled when the hand brakes are applied.



Disc Brake:

A disc brake is a type of brake that uses calipers to push a pair of pads against the rotating disc in order to create friction that retards the rotation of the wheel of the vehicle, either to reduce its rotational speed or to hold it stationary. The energy of motion is converted into waste heat which must be dissipated. After a certain no. of times of frictional action, the pads tend to get worn out.

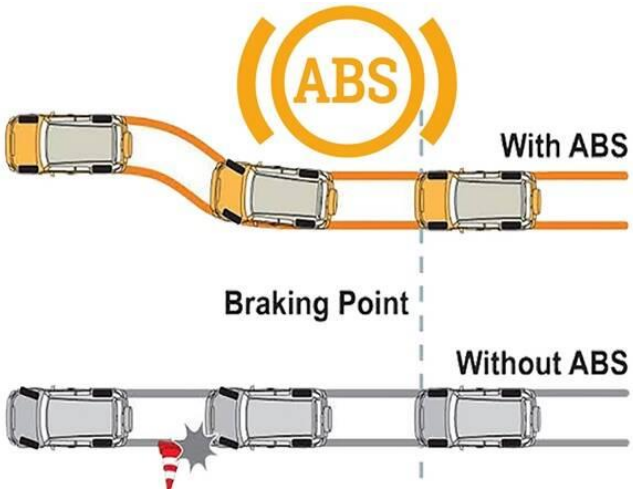
Compared to drum brakes, disc brakes offer better braking performance as the disc is more readily cooled as the vehicle keeps moving. As a consequence, discs are less prone to the brake failure caused when brake components overheat. Holes or vents are present on the discs in order to dissipate the heat that is produced.



Anti-braking system:

The most advanced development made in the braking mechanism is probably the Anti-lock Braking System (ABS). It is used predominantly in the disc brakes. In the pads of the calipers hit the disc and return and hit again, thus repeating this until the disc stops rotating. The speed of the pads in the ABS is calculated to be around 15 times per second.

The ABS braking proves to be very much efficient than the other brakes, especially in the corners. It tends to move the vehicle as the driver wishes to, without any topple or slip off the road. But it is mandatory that the vehicle must be at high speed to enable the ABS, (i.e.) the ABS is effective only at high speeds.



- Selection of a good material for the disc plate is very essential. The material must possess high strength-to-weight ratio, and high heat dissipation property.
- The pads of the calipers/drum are made of asbestos due to its good thermal conductivity.
- When air bubbles enter into the pressure line of the brakes, air bleeding is done. Air bleeding is the process of taking out the air that is mixed with the brake oil inside the pressure line.

Steering:

The basic mechanism of a vehicle which allows the driver to select the desired direction of travel. It consists of a steering wheel, steering wheel shaft, gear systems, stabilizers, etc. The most conventional steering system arrangement is to turn the front wheels using a steering wheel which is positioned right in front of the driver. The basic aim of a steering is to ensure that the wheels are pointing in the desired directions. This is typically achieved by a series of linkages, rods, pivots and gears which move accordingly to the response from the steering wheel given by the driver.

There are two common types of steering mechanisms:

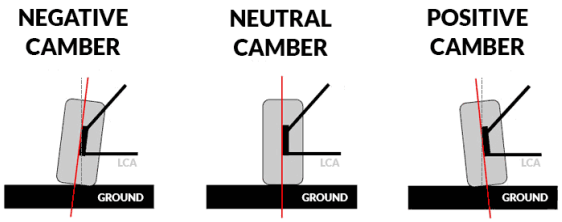
1. Rack and pinion type.
2. Worm type

Bump Steer:

Bump steer or roll steer is the term for the tendency of the wheel of a car to steer as it moves upwards. It is typically measured in degrees of steer per meter of upwards motion or degrees per foot. On modern cars the front of the tire moves outwards as the suspension is raised, a process known as the front wheels toeing out. This gives roll under steer. The rear suspension is usually set up to minimize bump steer, where possible.

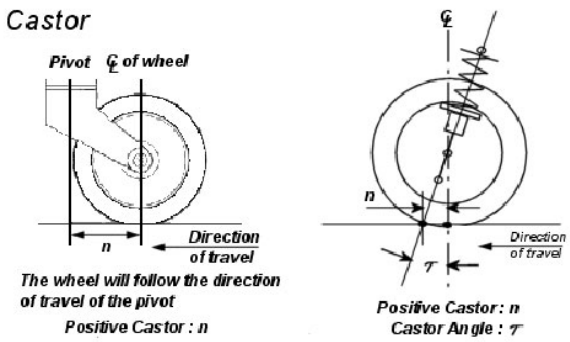
Camber angle:

Camber angle is the angle made by the wheels of a vehicle specifically, it is the angle between the vertical axis of the wheels used for steering and the vertical axis of the vehicle from the front view. It is used in the design of steering and suspension. If the top of the wheel is farther out than the bottom, it is called positive camber; if the bottom of the wheel is farther out than the top, it is called negative camber.



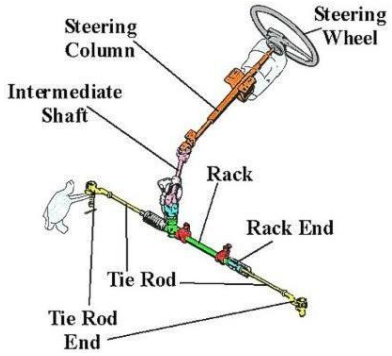
Castor angle:

The castor angle is the angle between the pivot line or the king pin axis and the positive castor or negative castor. The king pin is the main pin in a steering mechanism and responsible for steering action.



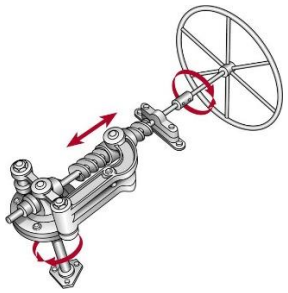
Rack and pinion steering:

A rack and pinion are a type of mechanism which comprises of a pair of gears which convert rotational motion into linear motion. A circular gear called the pinion engages teeth on a linear gear bar called the rack; rotational motion applied to the pinion causes the rack to move relative to the pinion, thereby translating the rotational motion of the pinion into linear motion.



Worm Steering:

A worm type steering is a gear arrangement in which a worm (a screw) rotates with a worm gear (a spur gear). The two elements are also called the worm screw and worm wheel. Like other gear arrangements, a worm drive can reduce rotational speed or allow higher torque to be transmitted.



Conclusion:

This report deomnstrates the summary about the automotives and their functions. The below picture shows the original frame which was developed during the internship.