UNIT 7

Suspension System

Contents

3QI7B

Learning objectives

1. Explain about the various types of Springs used in automobiles
2. Describe about the construction and working principle of various suspension system used in automobiles
3. Explain about the purpose types and operations shock absorbers

7.0 Introduction

Many sub systems are assembled to form an automobile. With this automobile, the passenger and goods are transported from one location to another location. During travelling, if the road shocks are transmitted to the chassis without absorption, then it will provide uncomfortable ride to the passengers as well as lead to failure of vehicle parts and goods transported. To prevent this, suspension systems are used and it is located between the axle housing and the vehicle chassis. Thus, the suspension system in automobile is a very important in deciding vehicle drive comfort and the stability of the vehicle.

7.0.1 Functions of suspension system

1. To reduce the effect of the shock and provide comfortable ride.
2. To prevent the damage of the vehicle parts when the vehicle travel over a rough road.
3. To prevent the steering system from road shocks
4. To prevent the occurrence of roll over when the vehicle travel over an irregular road.
5. To connect the chassis and frame.

7.0.2 Properties of Suspension system

1. The initial cost and the maintenance cost should be low
2. Wear and tear of the parts should be low
3. Weight should be less

7.1 Spring

Spring plays a vital role in a suspension system. Spring is located between the wheel axle and the vehicle body or frame. When the vehicle runs over a rough road, the spring absorb the road shock by compression and expansion. Some part of the shocks are absorbed by the tyres.

7.1 Spring Types

7.1.1 Steel Springs

7.1.2 Rubber Spring

7.1.3 Air Spring

7.1.4 Plastic Spring

7.1.1 Steel Springs types

1. Leaf spring
2. Coil Spring
3. Stabilizer Bar
4. Torsion Bar

7.1.1 Leaf Spring

Introduction

This type of springs is widely used in light and heavy commercial vehicles.

Construction

A leaf spring is built with number of leaves. The leaves are placed one over the other, and are held together by clamps and a bolt at the center. The leaves are usually given an initial curvature or chambered, so that they will tend to straighten under load. The spring is clamped to the housing by means of U – bolt. The longest leaf known as the main leaf or master leaf has its ends formed in the shape of an eye.

One end of the leaf spring is attached to the frame through shackle as movable. Another end is attached with anchor pin as non movable.

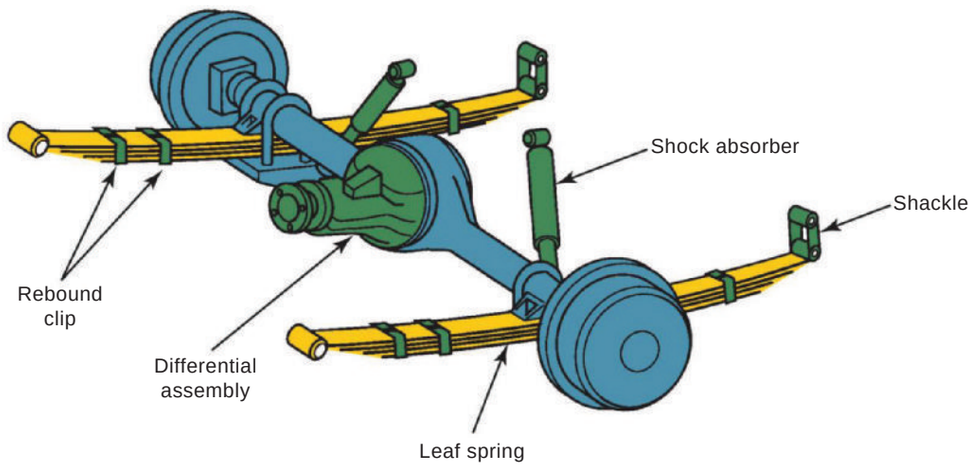
Working Principle

When the vehicle travel over a road undulation, the force from the road act on the leaf spring and the spring gets straightened. This variation in length is accommodated by the oscillation movement of the shackle. Thus, the road force makes the deflection of the leaf spring and absorb the vibration. During deflection, the energy is stored in the leaf spring and the stored energy is dissipated when the leaf spring retains its original position. Thus the road shocks are reduced and the ride comfort is increased.

In light commercial vehicles spring rubber or hard plastic bush are used. Phosphorus bronze bushes are used in heavy commercial vehicles. The lubricating oil with graphite is used in the bushes for lubrication.

Material

Chromium vanadium steel, Chromium- Nickel- Molybdenum steel, Silicon- manganese steel, are the typical materials that are used in the manufacturing of leaf springs.



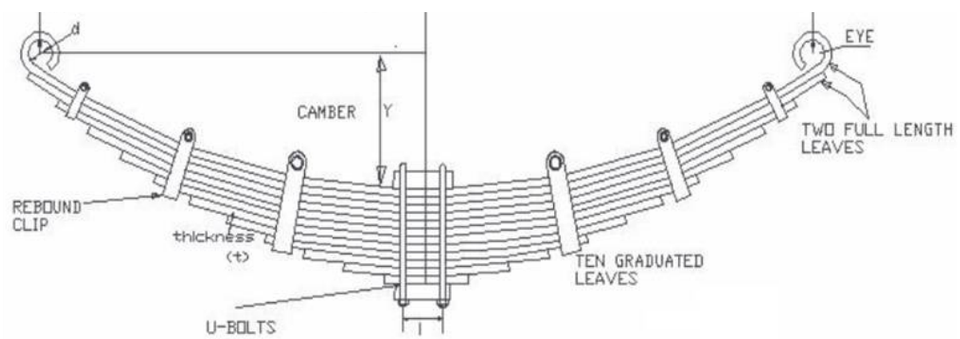


Figure 7.1.1 Leaf Spring

7.1.1.1 Type of Leaf Spring

7.1.1.1 (a) Quarter Elliptic Leaf Spring
7.1.1.1 (b) Semi Elliptic Leaf Spring
7.1.1.1 (c) Three Quarter Elliptic Leaf Spring
7.1.1.1 (d) Full Elliptic Leaf Spring
7.1.1.1 (e) Transverse Leaf Spring

(a) Quarter Elliptic Leaf Spring

The figure 7.1.1.1 (a) shows the simple arrangement. The one end is fixed on the side member of the frame by means of U Clamp or I Bolt while the other end is freely connected to the front axle. In such springs the camber is provided on the upward side so that the leaves tend to straighten when the front axle beam is subjected to shock load. The cost and the weight of this type spring is low. This is also known as the cantilever type leaf spring and it was used in olden days.

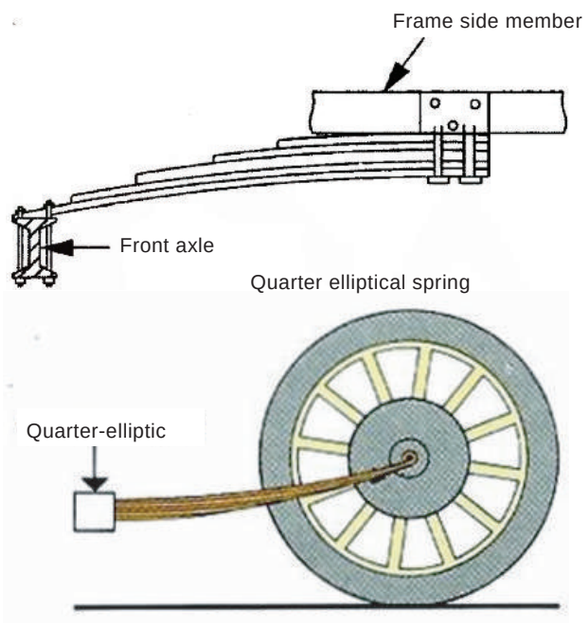


Figure 7.1.1.1 (a) Quarter elliptic leaf spring

(b) Semi-elliptical leaf spring

The simple construction is shown in the figure 7.1.1. (b). This type of arrangement is mostly used in automobile and it resembles the semi ellipse in shape. The leaf spring is made-up of a number of steel leaves. Each leaf is of a different length, but with equal width and thickness. The uppermost longest leaf having bushes at its two ends, is called the master leaf. The one end of the spring is rigidly fixed to the vehicle frame while the other end is attached with the help of shackle. The shackle accommodates the variation in the length while vehicle driving on rough terrains. This type of spring arrangement is requires less maintenance, easy to repair and it has long life.

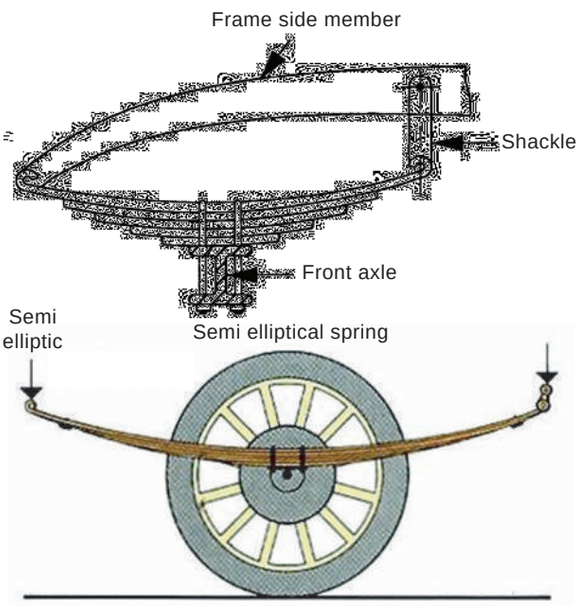


Figure 7.1.1.1 (b) Semi-elliptical leaf spring

(c) Three quarter elliptic leaf spring

The figure 7.1.1.1. (c) shows the arrangement. The three quarter elliptical spring is the combination of quarter elliptical spring and semi elliptical spring.

One end of the semi elliptical spring is attached to the frame through shackle and the other end of the semi elliptical spring is attached to the quarter elliptical spring by means of the shackle. The other end is bolted to the frames and being rigidly held by I – bolt. This type of arrangement was more popular in olden days and not used now-a-days.

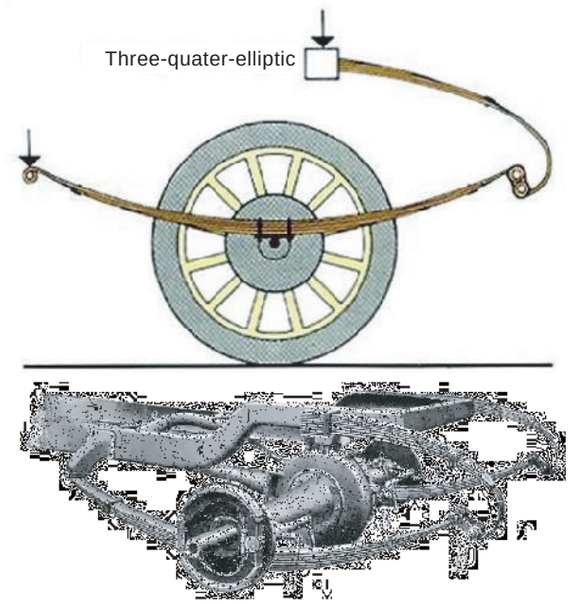


Figure 7.1.1.1 (c) Three quarter elliptic leaf spring

(d) Full Elliptic Leaf Spring

The simple construction of this type is shown in figure 7.1.1.1 (d). In this type, two semi elliptical springs are connected in opposite manner to form an elliptical shape. The full elliptical spring is attached rigidly to both the axle and the frame. Spring shackles are not necessary, since both the top and bottom members will elongate by the same amount when compressed. This arrangement was used in olden cars and not used now-a-days.

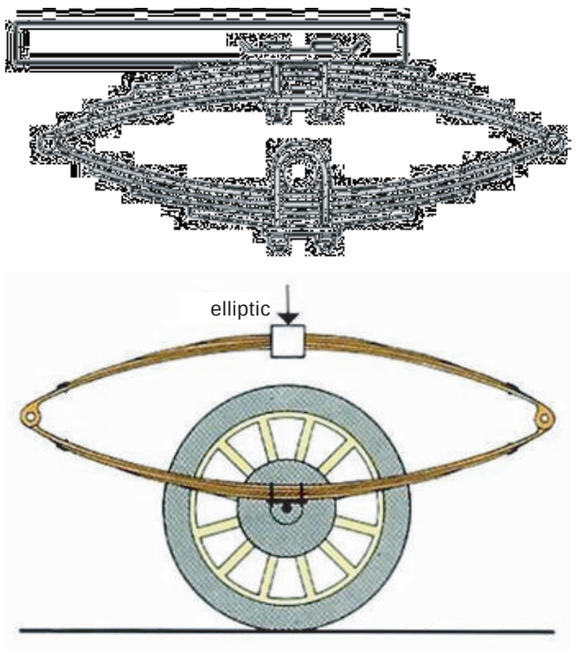


Figure 7.1.1.1 (d) Full elliptic leaf spring

(e) Transversely mounted semi-elliptical inverted leaf spring

The figure 7.1.1.1 (e) shows the arrangement. In this arrangement, a semi-elliptical leaf spring is mounted transversely along the width of the vehicle. The springs are placed, so inverted that the longest leaf is located at the bottom. The mid portion is fixed to the frame by means of U-bolt. The specialty of this arrangement is the use of two shackles. The rolling tendency of this type leads to its unsuitability for vehicles.

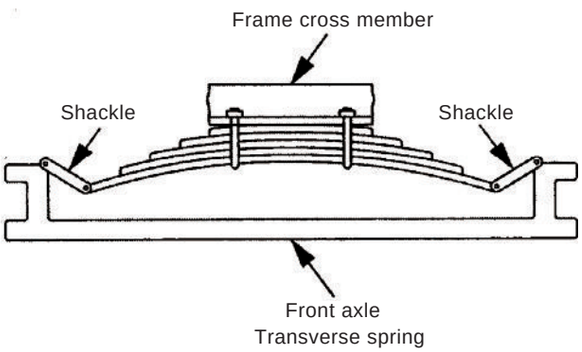


Figure 7.1.1.1 (e) Transversely mounted semi-elliptical inverted leaf spring

7.1.1.2 Coil Spring

Its simple layout can be seen in the figure 7.1.1.2. In this type one end of the spring is fixed with the frame, another end is fixed with the lower control arm. When the vehicle rises over a bump the spring gets compressed and it will absorb the energy. When the vehicle gets down from the bump the spring expanded and release the energy.

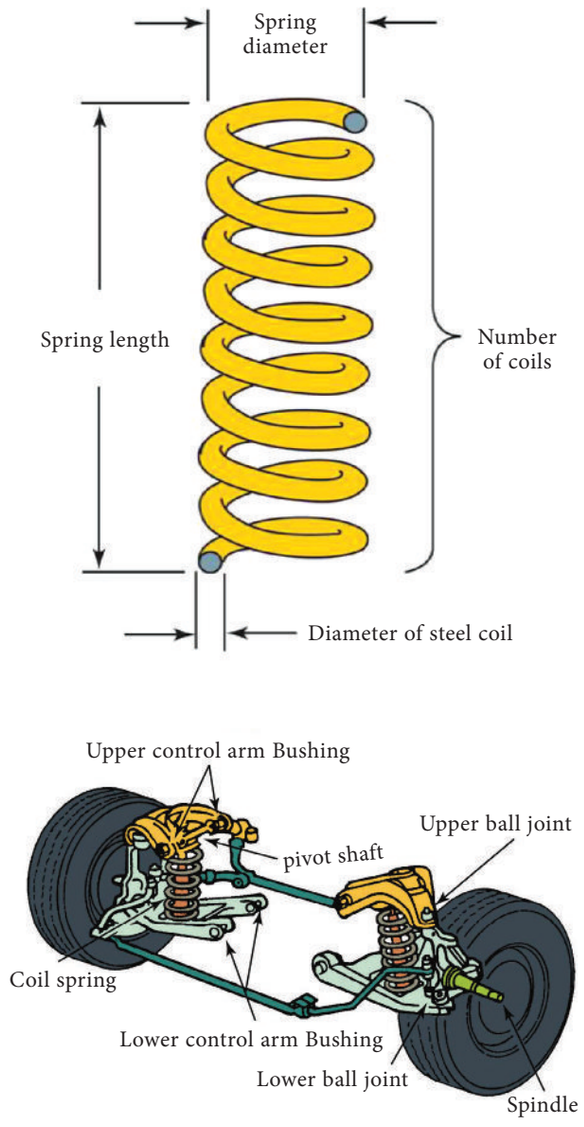


Figure 7.1.1.2 Coil spring

This type of suspension is commonly used in Independent Suspension Systems and in Light Vehicles. It can be used in both front and rear independent suspension systems. It absorbs energy twice than that of leaf spring. Coil spring can withstand shear stress and bending stress.

Advantages

1. Less noise
2. Less weight
3. Less space is enough.
4. Simple in design.

Disadvantages

1. It can not withstand the torque and lateral forces.

7.1.1.3 Stabilizer bar

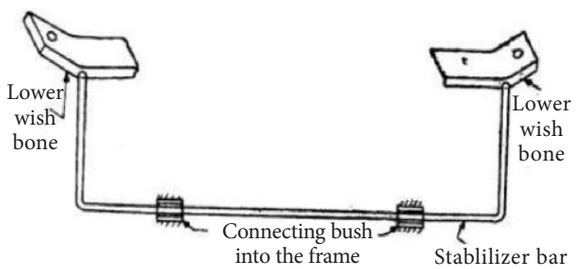


Figure 7.1.1.3 Stabilizer bar

The stabilizer bar is shown in figure 7.1.1.3. The stabilizer bar is mounted in between the two wheels. Stabilizer bars are part of a car's suspension system. They are sometimes also called anti-sway bars or anti-roll bars. The main purpose is to try to keep the car's body from "rolling" in a sharp turn. During turning, body roll occurs when more weight is placed on the outside tires and less weight is placed on the inside tires, which in turn reduces traction and vehicle control. The

stabilizer bar is used to make the body of the vehicle will remain flat throughout a turn so the weight stays evenly distributed on all four tires. It is like a U shaped bar which used in front independent suspension system.

7.1.1.4 Torsion Bar

The simple layout of torsion bar is shown in the figure 7.1.1.4. The torsion bar is made up of hardened steel alloys. It works based on the torque principle. It is used in the independent suspension system. The one end of the torsion bar is fixed with frame and another end is fixed with wheel arm. Wheel arm is supported by bearing. Another end of wheel arm is attached with the wheel hub spindle.

While travelling in bumpy road, the vibration absorption takes place by twisting. To fix the torsion bar, a minimum space is required.

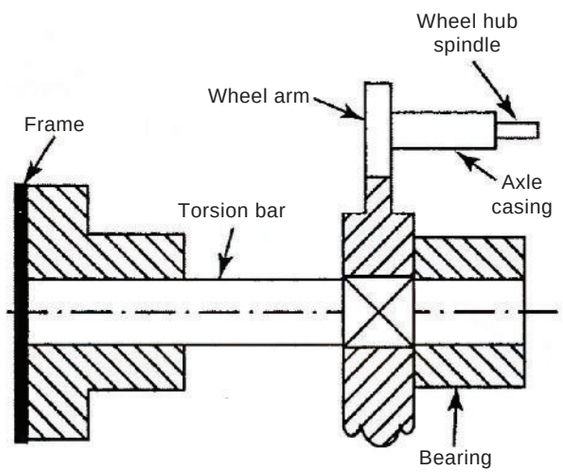


Figure 7.1.1.4 (a) Torsion bar

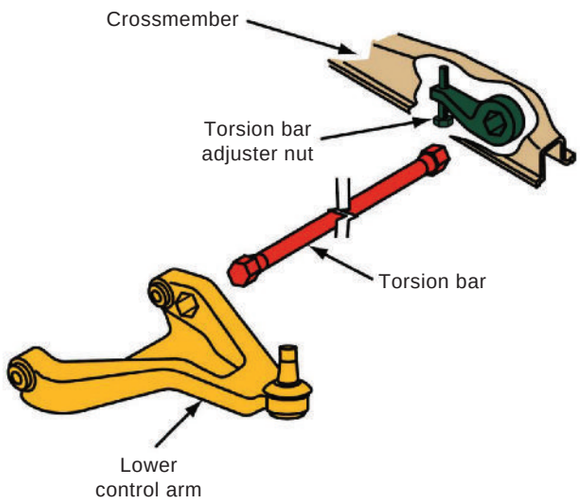


Figure 7.1.1.4 (b) Torsion bar

7.1.2 Rubber Spring

The layout of rubber spring is shown in figure 7.1.2. Rubber springs are used in suspension systems. It absorbs more vibrations than metal springs. There are different types of rubber springs are used.

1. Compression spring
2. Compression shear spring
3. Steel reinforced spring
4. Progressive spring

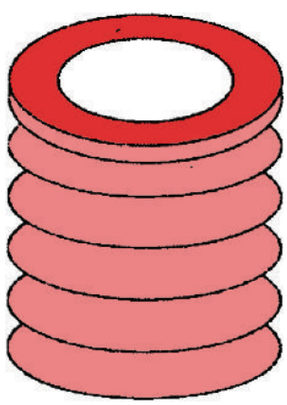


Figure 7.1.2 Rubber Spring

Advantages

1. It has the ability to store more energy than steel and iron springs.
2. It will not break suddenly like metallic springs.
3. The life of the spring is higher.
4. Rubber can withstand vibrations very well.

7.1.3 Air Spring

The layout of air spring is shown in figure 7.1.3(1&2). Air spring gives more comfort and smooth ride to the travellers. It provides more comfortable ride when the vehicle is unloaded and loaded conditions. They are classified into two types, namely,

7.1.3 1. Bellow Type
2. Piston Type

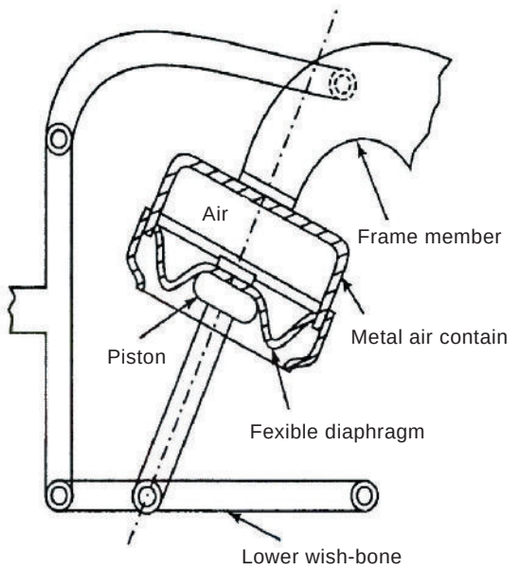


Figure 7.1.3 (2) Piston Type

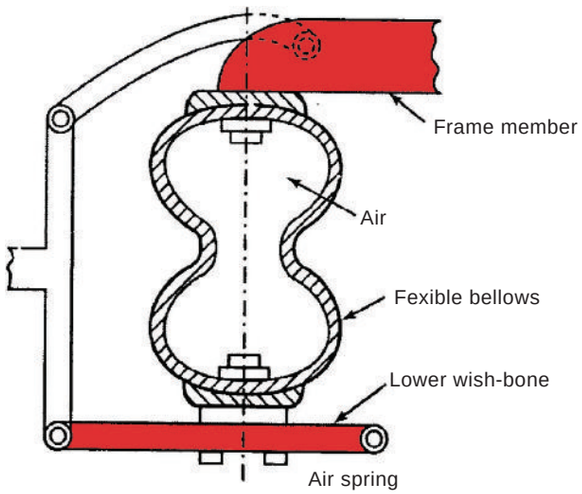


Figure 7.1.3 (1) Bellow Type

7.2 Helper Spring

This system is widely used in heavy commercial vehicles, trucks. This helper spring does not function during light load condition. As the load increases, beyond a certain level, the spring will start functioning. The helper spring is integrated along with the Master leaf in leaf spring. Due to the increased load, the master leaf spring and helper leaf gets fully expanded and the helper spring touches the special bracket, makes the helper leaf to function. This type of helper leaf is widely used in the rear axle.

7.3 Types of suspension system

1. Conventional suspension system
2. Front or Rear independent suspension system
3. Air suspension system
4. Hydro elastic suspension system

7.3.1 Conventional suspension system

In this type, wheels are mounted on the two sides of the axle. Leaf spring or coil spring is mounted in between the chassis frame and axle. One end of the leaf spring is attached rigidly usually the front, and the other end is attached through a shackle as movable. The vibration is absorbed by the compression and expansion of leaf spring while travelling over a road with bump and pit. Two ends of the master leaf are connected with the kingpin and knuckle, so that vibration transferred from one side to another. These types of suspension systems are mostly used in rear wheels alone.

Advantages

1. Simple in design
2. Low cost
3. Less number of components
4. Less maintenance

Disadvantages

1. Road shocks from one wheel is transmitted to another wheel. If the road is irregular, the whole vehicle leans on one side.
2. As both the wheels do not get up or down simultaneously, so they will rotate in different positions.

Note

Due to the gyroscopic effect during turning, wheel wobble or wheel shimmy takes place in a wheel. This is a very dangerous problem.

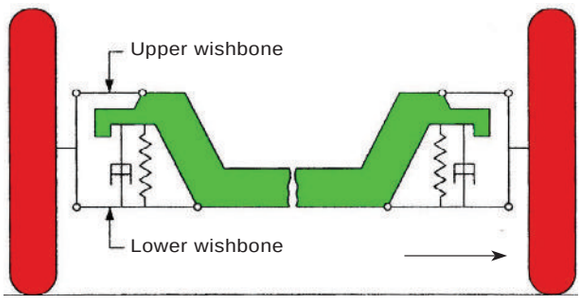
7.3.2 Independent Suspension system

Independent Suspension systems are commonly used in the front axle. When a wheel climbs a bump, the other wheel will travel in its own path. Hence, the vibration will not be transmitted from one wheel to another which leads to smooth ride to the passenger.

Types of Independent front suspension system

1. Wishbone or Parallel link type.
2. Vertical guide type
3. Trailing link type
4. Macpherson strut type
5. Swing half axle type.

7.3.2.1 Wishbone suspension system



Wishbone type independent suspension with coil spring

Figure 7.3.2.1 Wishbone suspension system

This system is shown in the figure 7.3.2.1. This type of suspension system is often used for front wheels. In this system, two arms namely upper wishbone arm and lower wishbone arm are used. The upper wishbone has a short arm and lower wishbone is a long arm and it is connected with the frame. Vibration damper and coil spring are fixed over the rubber pad in between the lower wishbone arm and fixed cross member.

Wishbone Arms keep the wheel in its position and transmit the load to the spring. Therefore, the tractive force,

brake force and lateral force get absorbed. Due to the shortened length of the upper arm the tire wear gets reduced.

Special Features

1. Since length of upper wishbone is shorter than the lower wishbone, wheels are slightly inclined. This leads to no slip in the tyre and the wheel track does not change and hence the tyre wear is reduced.
2. The two wishbone arms help in positioning the front wheels and they withstand the braking torque while braking.
3. There is no effect on one wheel while other wheel travels through ups and downs in the road.

7.3.2.2 Vertical guide suspension system

The simple layout is shown in figure 7.3.2.2. It is the first developed independent front suspension system. In this suspension the kingpin is directly attached to the cross member of the frame and spacing rod. The coil spring is fitted as shown in the figure.

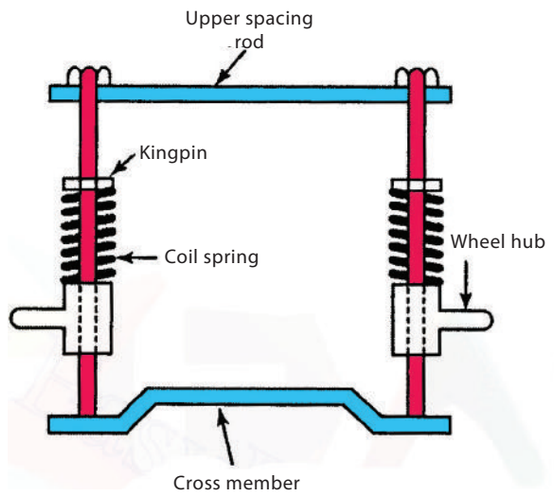


Figure 7.3.2.2 Vertical guide suspension system

When the wheel travel over the bumpy road, spring compress or expands and this makes the stub axle to slide up and down. In this type, caster angle, camber angle and wheel direction are remained unchanged as the wheel moves up and down. However, the disadvantage is less strength.

Notes

1. While the vehicle running, the sliding member is also moving up and down. Therefore, the spring gets compressed and elongated continuously.
2. When the specific wheel going through up and down, the sliding member is also moving up and down. However, the castor and camber angle will not change.
3. This is system cannot be used because of its less strength.
4. The efficiency of the system is based on the sliding member movement accuracy.
5. It is difficult to avoid the shock and less holding that can occur.

7.3.2.3 Trailing link types

Construction

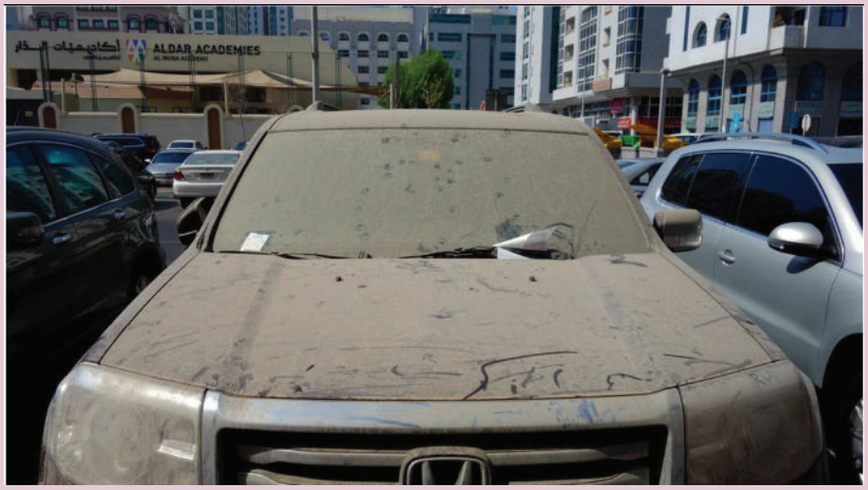
The figure 7.3.2.3 shows the construction of the trailing link type. In this type of suspension system, coil springs are positioned between cross member and the trailing link. On the other side of the trailing link, wheels are fixed. In some vehicles, torsion bars are used instead of horizontal coil spring.

Working principle

When the vehicle wheel passing over the bumps and pits, trailing arm oscillates

DO YOU KNOW?

In Russia it's considered a criminal offense to drive with a dirty car. 16% of people never wash their car.



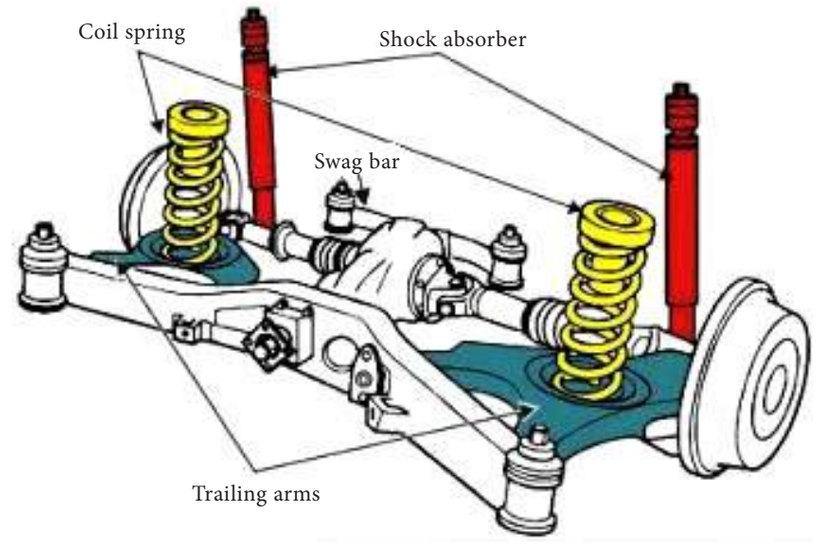
like a springboard. The road disturbance is absorbed by spring deflection. Multiplate shock absorber is used to dissipate the stored energy in spring. This type of suspension system usage is very limited in vehicles, it is because of the maintenance and repair of this suspension system are complex in nature.

7.3.2.4 Mac Pherson Strut types

Constructions are shown in the figure 7.3.2.4.

Introduction

It is named after American automotive engineer Earle S. Mac Pherson, who originally invented and developed the design. It is widely used in the front suspension vehicles. The MacPherson Strut type suspension system consists of with a telescopic strut and a single arm along with a diagonal stay. Lower Wishbone arm is alone available in this system. Shock absorber and spring are



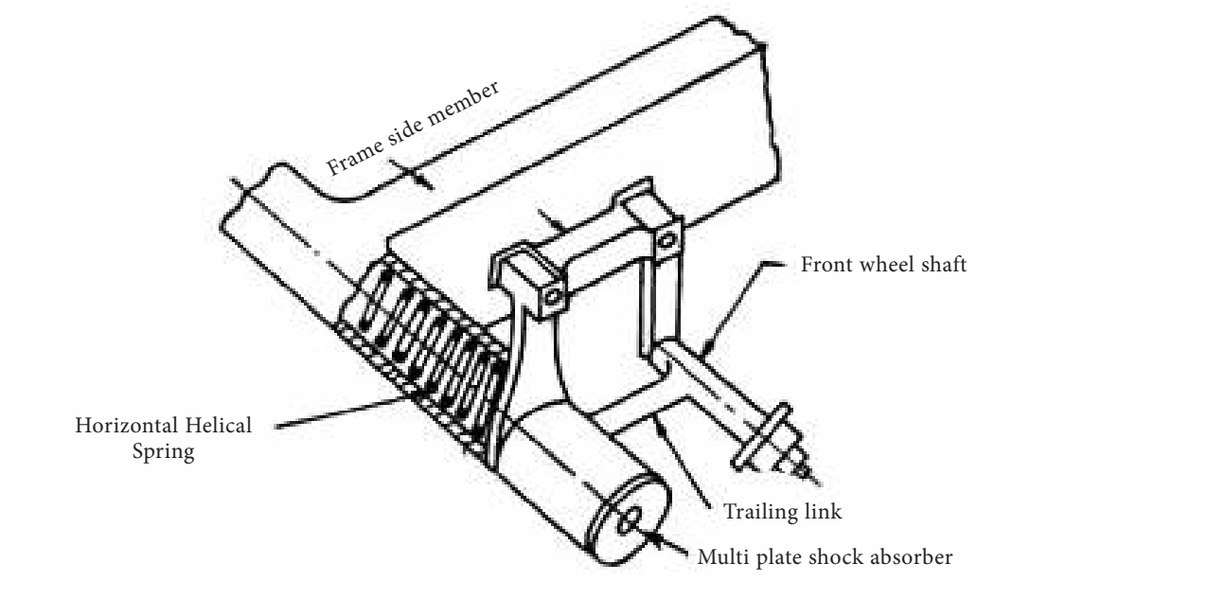


Figure 7.3.2.3 Trailing link suspension

acting as an integrated unit known as strut. Stub axle support the strut and stub axle hold the wheel.

When the vehicle wheel moves over the bumps and pits, Camber angle remains unchanged. It provides more amount of space to mount engine. Hence, this is most widely used in front wheel drive vehicle like Maruthi 800, Hyundai.

Advantages

1. Simple in construction
2. Minimum number of parts
3. Ease of maintenance

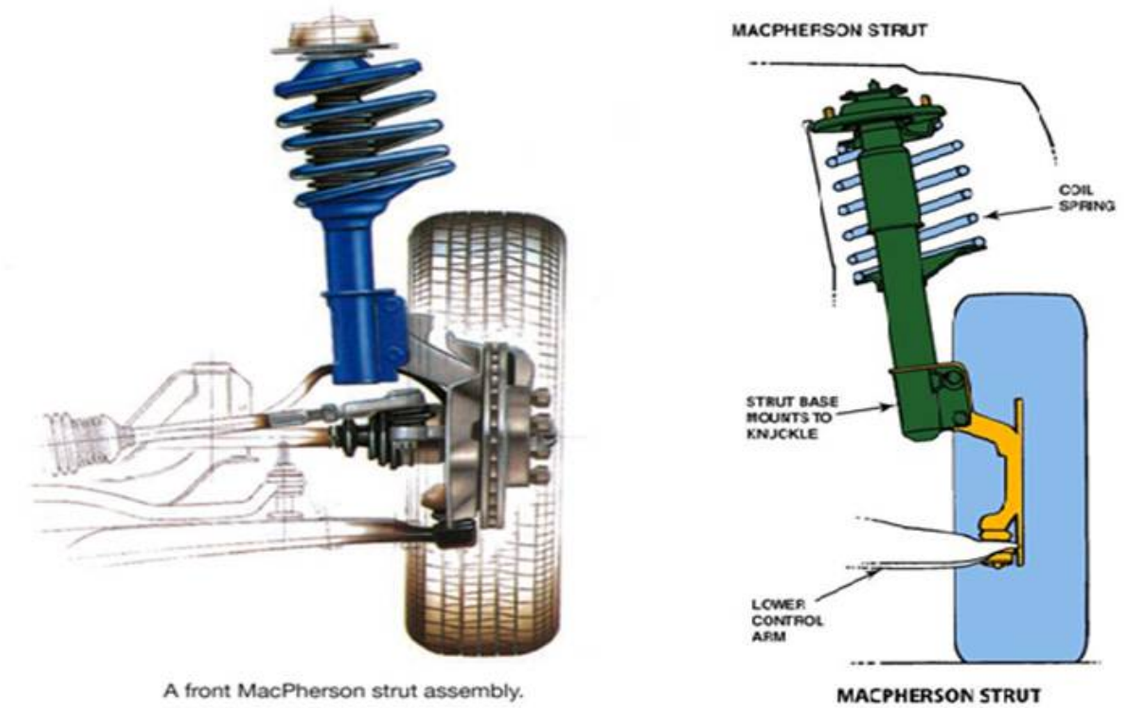
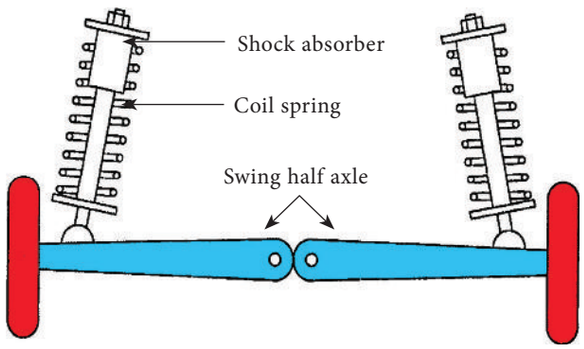


Figure 7.3.2.4 MacPherson Strut types

7.3.2.5 Swing half axle types

The simple construction is shown in the figure 7.3.2.5. Wheels are firmly fixed on one end of the half axle and the other end of the half axle is fixed to the center point of the chassis frame. Coil spring and shock absorber are mounted as shown in the figure. When the wheel passes the bumps and pits, axle get oscillates. As the vehicle moves on the irregular roads, coil spring and shock absorber are stretched or compressed simultaneously to take the road disturbances.



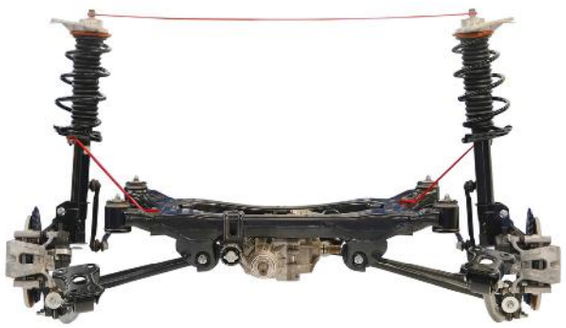


Figure 7.3.2.5 Swing half axle types

7.3.2.6 Rear axle independent suspension system

Rear axle independent suspension system construction is given in the figure 7.3.2.6. In most of the vehicles, the drive from the engine is given to the rear wheels. Hence it is difficult to design, construct and installing an independent suspension system in rear wheel drive vehicles. The differential unit is firmly fixed on the chassis cross frame member. Two

universal joints (A & B) are there in between differential unit and wheel, movable coupling (C) allows to move up and down motion of the wheel. A shock absorber is incorporated to the system. With the help of these components, the system absorb the road disturbance when the vehicle passes over the bumps and pits.

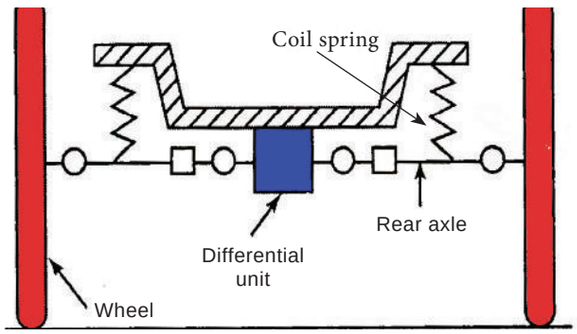


Figure 7.3.2.6 Rear axle independent suspension system

7.3.3 Air suspension system

These types of suspension systems are commonly used in a long-distance vehicle like buses. Due to the benefits of the air suspension system, nowadays this system is widely used in many vehicles.

Schematic representation of this type of air suspension system is shown in the figure 7.3.3(1&2). It consists of four air springs which may be a bellow type or piston type. Air compressor is used to pressurize the purified air (through filter) from the atmosphere and stored in the accumulator at a pressure maintained between 5.6 to 7 kg/cm^2. To release the excess air and to maintain the pressure inside the accumulator, a safety relief valve is used. The high pressure compressed air enters into the air spring through leveling valve and lift control valve. The lift control valve was operated by a manual lever which is located in the panel board.

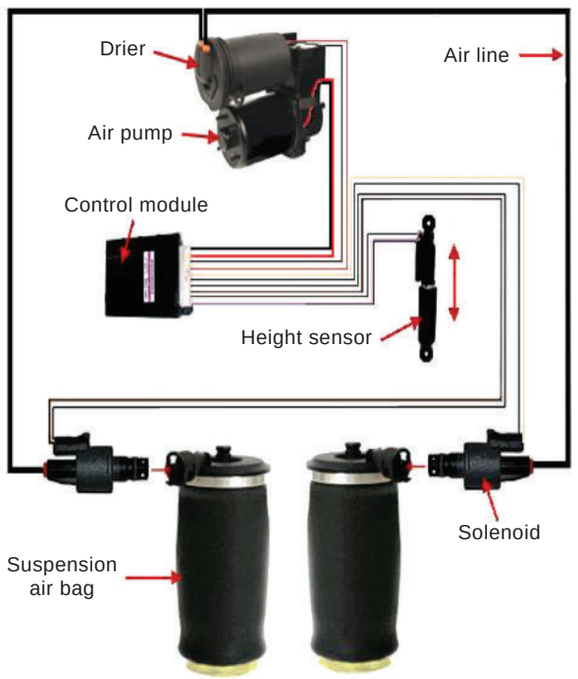


Figure 7.3.3 (1) Air suspension system

Advantages

1. It reduces noise, vibration, and harshness due to which passenger and driver attain better ride comfort. It reduces the journey tiredness of the driver and the passenger.
2. Change of spring deflection is quite low when compared with a conventional suspension system for both loading and unloading condition. This helps to reduce the load transfer on the vehicle.
3. Headlamp alignment remains constant though the vehicle is travelling over irregular roads.
4. With the help of automatic controlling tools, this system will provide some space for required wheel movement.

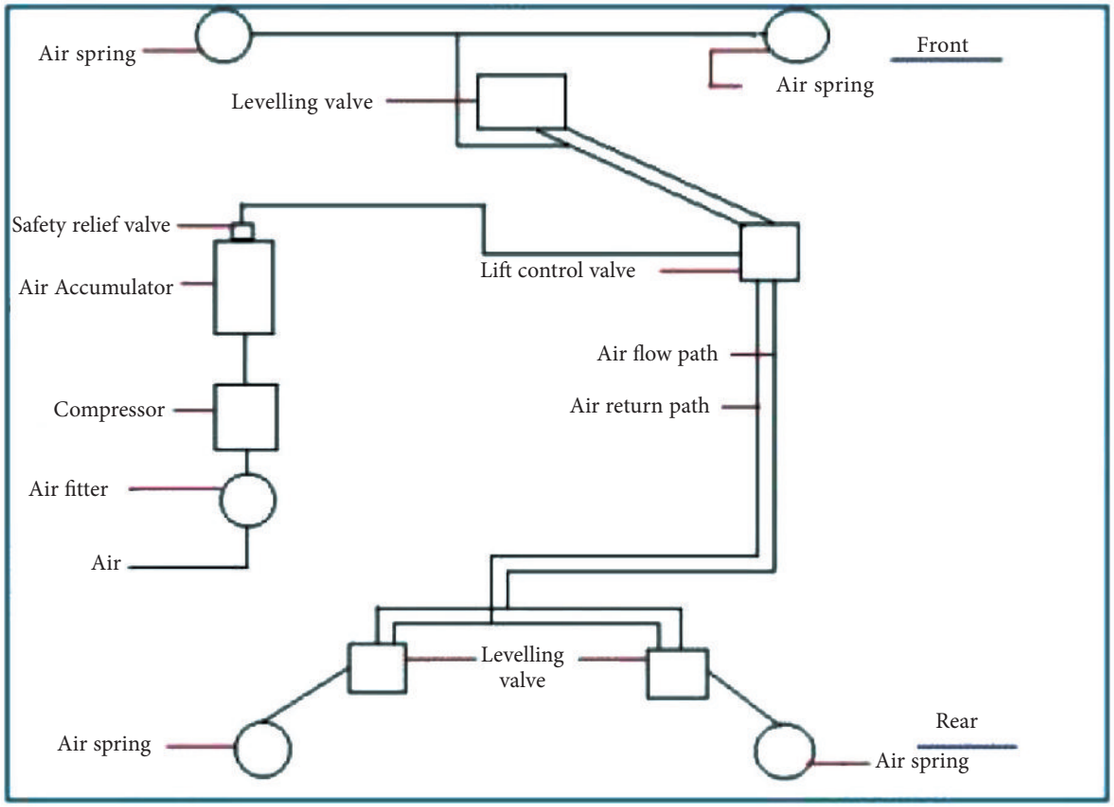


Figure 7.3.3 (2) Air suspension system

7.4 Independent suspension system advantages and disadvantages

Advantages

1. When one side of the wheel is subjected to road disturbance, then this disturbance does not transmit to the other side of the wheel.
2. During cornering, the rollover, the skid, pull on one side etc will not occur.
3. It provides good road holding property.
4. It promotes easy turning of the vehicle and have better control.
5. It ensures good ride quality.
6. It prevents the wheel from turning towards the kingpin axis.
7. In front wheel steering vehicles, it provides space to locate the engine.
8. It reduces the unsprung weight.
9. It controls the effect of steering geometry hence steering is easier.

Disadvantages

1. It has more probable for tyre wear.
2. Comparatively, the cost is high.
3. Requires more maintenance and it is complex.
4. Maintenance cost is high.
5. It requires good quality shock absorber to enhance the ride comfort.
6. Construction is complex.
7. More benefits when it is mounted in the front axle than rear axle.

7.5 Shock absorber

The spring system prevents the travelers and truckloads that do not cause any shocks when climbing up the sudden disturbance on the road. However, if the spring are stiffer than expected, it will not absorb the road shock. The spring will keep on oscillate even after crossing the disturbance till the energy is completely die out. Hence, to quickly dissipate the stored energy in springs, dampers are used.

According to the working principle shock absorber are classified into three types they are,

1. Friction type
2. Hydraulic type
3. Air type

7.5.1 Friction type

When one body is allowed to slide over the other, the surface of one body offers some resistance to the movement of the other body on it. This resisting force is called friction force. In leaf spring, the interleaf friction is act as a damper. It is not widely used with other types of springs.

7.5.2 Hydraulic type

This type of damper is most widely used in the suspension system. It works based on Pascal'slaw. They are further classified into two types.

(i) Pistontype
(ii) Telescopic type

Telescopic type

It works on the basic principle of Pascal's law. Damping is obtained as high-velocity fluid passing through a tiny hole. This system is also called telescopic shock absorber and because of use of hydraulic, it is also called as hydraulic damper.

Construction

Figure 7.5.2.2 shows the construction details of this shock absorber. The head is fixed inside the cylinder. The piston and two way valve located on the top portion of the Cylinder is assembled with piston rod for up and down motion. The other end of the piston rod has eye and it is attached to the chassis frame. On the bottom portion of the cylinder another two way valve named as foot valve is attached. In this two way valve, one valve is used for fluid inlet and other valve is used for fluid outlet. Cylinder is filled with fluid.

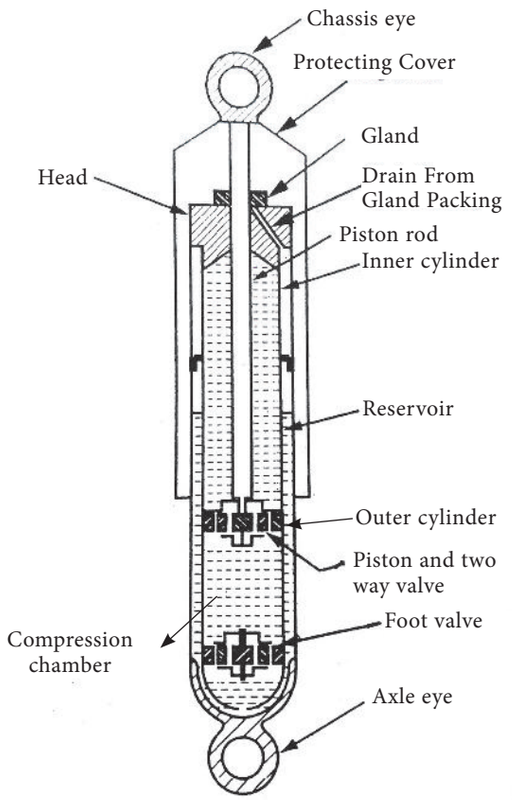


Figure 7.5.2.2 Telescopic type shock absorber

Inner portion of the cylinder is called as tube and the gap between the outer portion of the inside tube and that of the inner portion of the outside tube is used for fluid storage and it is called as reservoir. A gland is fixed at the top portion of the cylinder. When damper is in operation, Gland is used to scrap the excess oil in the piston rods to the reservoir. When suspension works, fluid from the glands has been sent it to reservoir through piston rods.

The lower portion below the piston of the inner cylinder, is called as compression chamber and the top portion above the piston is called as rebound chamber. Damping fluid is made up of with 60% transform oil blended with 40% turbine oil.

Working principle

When the vehicle passes over the road disturbance, it piston moves down and this movement of piston pressurizes the fluid at the bottom portion. Then this fluid flows into the rebound chamber from compression chamber through a valve located on the top portion of the piston and the remaining portion flows into the reservoir through foot valves.

Similarly, when the vehicle comes to normal road condition, the piston moves from downward to the upward direction, so that the fluid at the top portion of the piston is compressed. This pressurized fluid is sent inside the compression chamber through the piston valve and the remaining amount of the fluid which again fed back from the reservoir through the foot valves. Because of this upward and downward motion of the piston, the fluid becomes highly pressurized and hence the energy due to road shock has been absorbed.

7.5.3 Air type

Air suspension is nowadays the most popular on commercial vehicles. It works on the principle of air so it is called as air type shock absorber.

7.6 Troubles, Causes and remedies of the suspension system

7.6.1 Noise in the suspension system

Sl. No.	Causes	Remedies
1	Loose, worn, un lubricated spring or suspension parts	Lubricate, tighten or repair
2	Worn out bushes	Replace the bush
3	Weak / Broken / Defective spring	Replace
4	Worn out shackle pin	Replace

7.6.2 Frequent failure in leaf spring

Sl. No.	Causes	Remedies
1	Defective shock absorber	Replace
2	Vehicle heavily loaded	Avoid overload
3	Tight spring shackle	Loosen, Rectify / Replace
4	Sudden brake in high speed	Apply brake gradually

7.6.3 Uncomfortable ride in vehicle

Sl. No.	Causes	Remedies
1	Misalignment of suspension system	Align the system
2	Defective shock absorber	Rectify / replace
3	Loosened U-Bolt	Tighten
4	Seized shackle pin	Clean and lubricate / replace the damaged parts

- Hong Kong is home to the most Rolls Royce's in the world.

- Red cars are prohibited in Shanghai, China.

- 1 out of every 4 cars produced in the world come from China.

- The world's most profitable car manufacturer is Porsche.

Student Activity

1. Students are advised to submit a report based on visit to nearest Automotive workshop to study how suspension system is installed in a vehicle.
2. Students are advised to submit a report on construction and working principle of air suspension system used in modern Automobiles with line sketches.

Glossary

1.	Plastic	–	நெகிழி
2.	Leaf Spring	–	பட்டை வில் தொகுப்பு
3.	Coil Spring	–	சுருள் வில்
4.	Bellow type	–	மடிப்புரை வகை
5.	Shackle	–	அசைவுக்கரம்
6.	Cantilever	–	நெடுங்கை
7.	Torsion bar	–	முறுக்கு தண்டு
8.	Shock Absorber	–	அதிர்வு உறிஞ்சி
9.	Face Shear	–	முகப்பு வெட்டு
10.	Reinforced	–	வழுவூட்டப்பட்ட

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Evaluation

543CS

PART - A

One mark questions

Choose the correct answer

1. In leaf spring, one end of the spring is fixed and the other end of the spring is attached to _____
   a) U - bolt
   b) I - bolt
   c) Shackle
   d) Axle shaft

2. The up and down motion of the vehicle is called as _____
   a) Damping
   b) Bouncing
   c) Pitching
   d) Rolling

3. Energy stored in the coil spring during
   a) Compression
   b) Straightening
   c) Expansion
   d) Bending

4. Hydraulic damper is working based on the principle of
   a) Newton Law
   b) Principle of Lever
   c) Principle of friction
   d) Pascal Law

5. In which type of vehicle, helper springs are used?
   a) Light vehicles
   b) Heavy vehicles
   c) Two wheeler
   d) Three wheeler

PART - B

Three mark questions

1. State the requirements of a suspension system?
2. Classify the types of leaf spring?
3. Write short notes on helper spring.

4. What will happen if suspension system fails?
5. State the advantage of rubber Springs?
6. Classify the types of suspension system
7. State the types of air spring?
8. List out the types of shock absorber.
9. How leaf spring is mounted on a vehicle?
10. State the function of suspension system?

PART - C

Five mark questions

1. With the aid of neat sketch, explain torsion bar.
2. Draw any one type of leaf spring and indicate its parts.
3. State the advantage of air suspension.
4. Highlight the advantage and disadvantage of a coil spring.

PART - D

Ten mark questions

1. State the advantage and disadvantage of independent suspension system?
2. With the aid of simple sketch, explain the construction and working principle of shock absorber.
3. Explain with neat sketch, the principle of wishbone type suspension system.
4. With the aid of line diagram, explain the construction and working principle of air suspension system.