MODULE CONTENT

| Unit of Competency | **DIAGNOSE AND REPAIR SUSPENSION SYSTEM** |
| --- | --- |
| Module Title | **DIAGNOSING AND REPAIR SUSPENSION SYSTEM** |
| Module Descriptor | This unit identifies the competencies required to diagnose and repair the suspension system. |
| Nominal Duration | **hours** |
| Summary of the Learning Outcomes: | |
| Upon completion of this module the student must be able to: | |
| LO1. Prepare to diagnose and repair suspension system | |
| LO2. Diagnose suspension | |
| LO3. Repair suspension system | |
| LO4. Complete work processes | |

**LEARNING EXPERIENCES**

**LEARNING OUTCOMES NO. 1**

**PREPARE TO DIAGNOSE AND REPAIR SUSPENSION SYSTEM**

| **Learning Activities** | **Special Instructions** |
| --- | --- |
| Read Information Sheet 3.1-1 Prepare to diagnose and repair suspension system | If you have some problem with the content of the information sheet don’t hesitate to approach your Trainer.  If you feel that you are now knowledgeable on the content of the information sheet, you can now answer the self-check provided in the module. |
| Answer Self-Check 3.1-1 on Prepare to diagnose and repair suspension system | Try to answer the Self-check without looking at the Answer Key  Compare your answer to Answer Key 3.1-1 |
| Observe Trainer’s demonstration on Task Sheet 3.1-1 on Prepare to diagnose and repair suspension system | Listen carefully and attentively so that you may be able to perform a task correctly  Ask questions if are in doubt for clarification |
| Perform the Task Sheet 3.1-1 on Prepare to diagnose and repair suspension system | Remember the step-by-step procedure the Prepare to diagnose and repair suspension system |
| Evaluate the performance using the Performance Criteria Checklist 3.1-1 | Repeat the task in case fail to meet the criteria |

**INFORMATION SHEET 1.1-1**

**PREPARE TO DIAGNOSE AND REPAIR SUSPENSION SYSTEM**

**Learning Objectives:**

After reading this **Information Sheet**, you must be able to:

1. Made final inspection.
2. Turned-over vehicle.
3. Restored work area.
4. Managed wastes.
5. Checked and stored tools and equipment.
6. Accomplished workplace documents.

**SUSPENSION SYSTEM**

Like the rest of the systems on cars and light trucks, the suspension system has generally changed through the years. Not only has technology brought about these changes, so has the quest for great handling and comfortable vehicles. Suspension systems for the front and rear of a vehicle can get quite complex **(Figure 43-1).**

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**Figure 43-1** The suspension system for a late-model car. The front uses a strut setup, while the rear has a multilink system.

The reason suspension systems are complex is that they perform a very complicated function. These systems must keep the vehicle’s wheels lined up with the travel of the vehicle, limit the movement of the vehicle’s body during cornering and when going over bumps, and provide a smooth and comfortable ride.

**FRAMES**

To provide a rigid structural body-over-frame construction, the frame is the vehicle’s foundation. The body and all major parts of a vehicle are attached to the frame. It must provide the support and strength needed by the assemblies and parts attached to it. In either worlds, the frame is an independent, separate component because it is not welded to any of the major units of the body shell.

**Unibody Construction**

Unibody construction has no separate frame. The body is constructed in such a manner that the body parts themselves supply the rigidity and strength required to maintain the structural integrity of the car. The unibody design significantly lowers the base weight of the car, and that, in turn, increases gas mileage capabilities.

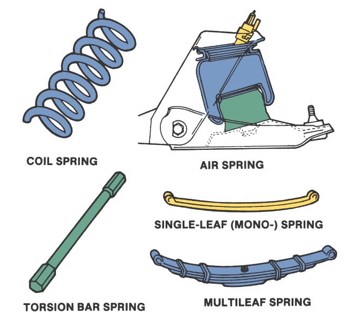
**SUSPENSION SYSTEM COMPONENTS**

Most automotive suspension systems have the same basic component and operate similarly. Their differences are found in the method in which the basic components are arranged.

**Springs**

The springs is the core of nearly all suspension systems. It is the component that absorbs shock forces while maintaining correct riding height. If the spring is worn or damaged , the other suspension elements shift out of their proper positions and are subject to increase wear. The increased effect of shock impairs the vehicle’s handling/

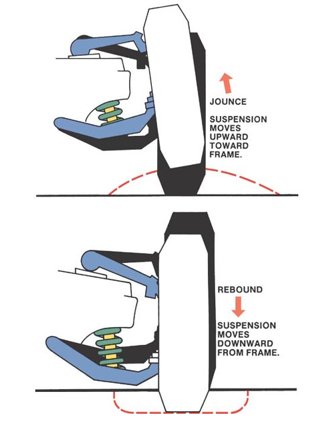
Various types of springs are used in suspension systems-coil, torsion bar, leaf (both mono- and multileaf types) **(Figure 43-2)** and air springs. Springs are rubber mounted to reduce road and noise.



**Figure 43-2** Various types of automotive springs.

Automotive springs are generally classified by the amount of deflection exhibited under a specific load. This is referred to as the spring rate. According to the law of physics, a force (weight) applied to a spring causes it to compress in direct proportion to the force applied. When that force is removed, the spring returns to its original position if no overloaded. Remember that a heavy vehicle requires stiffer than a lightweight car.

The spring take care of two fundamental vertical actions: jounce and rebound. **Jounce** occurs when a wheel hits a bump and moves Up **(Figure 43-3A).** When this happens, the suspension system acts to pull in the top of the wheel, maintaining an equal distance between the two front wheels and preventing a sideways scrubbing action as the wheel moves up and down. **Rebound** occurs when the wheel hits a dip or hole and moves downward **(Figure 43-.3B).**  In this case, the suspension system acts to move the wheel in at both the top and bottom equally, while maintaining an equal distance between the wheels.



**Figure 43-3** (A) Upward and (B) downward suspension movement.

The spring goes back and forth from jounce and rebound become smaller and smaller. This is caused by friction of the spring’s molecular structure and the suspension pivot joints. A **shock absorber** is added to each suspension to dampen and stop the motion of the spring after jounce.

All of the vehicle’s weight supported by the suspension system is known as **sprung weigth.** The weight of those components not supported by the springs is known as **unsprung weight.**  The vehicle’s body, frame, engine, transmission, and all of its components are considered as sprung weight. Undercar parts classified as unsprung weight include the steering knuckles and rear axle assemblies (but not always the differentials). Keep in mind that, in general, the lower the ration of unsprung weight, the better the vehicle will be.

**Coil Springs** Two basic designs of coil springs are used: linear and variable rate. **Linear rate** sprigs characteristically have one basic shape and a consistent wire diameter. All linear springs are wound from a steel rod into a cylindrical shape with an even spacing between the coils. As the load increased, the spring is compressed and the coils twist (deflect). As the load is removed the coil flex (unwind) back to the normal position. The amount of load necessary to deflect the spring 1 inch (25.4 mm) is the spring rate. On linear rate spring this is constant rate, no matter how much the spring is compressed. For example, 250 pounds (112 kg) compress the spring 1 inch (25.4 mm) and 750 pounds (340 kg) compress the spring 3 inches (76.2 mm). Spring rate for linear rate springs are normally calculated between 20% and 60% of the total spring deflection.

**Variable rate** spring designs are characterized by a combination of wire sizes and shapes. The most commonly used variable rate springs have consistent wire diameter, are wound in a cylindrical shape, and have unequally spaced coils. This type of spring is called a progressive rate coil.

The design of the coil spacing gives the spring three functional ranges of coils: inactive, transitional, and active. Inactive coils work usually the end coils and introduce force into the spring. Transitional coils become inactive if they are compressed to their point of maximum load-bearing capacity. Active coils work throughout the entire range of spring loading. Theoretically in this type of design, at stationary loads the inactive coils are supporting of a vehicle’s weight. As the loads are increased, the transitional coils take over until they reach maximum capacity. Finally, the active coils carry the remaining over-load. This allows for automatic load adjustment while maintaining vehicle height.

Another common variable rate design uses tapered wire to achieve this same type of progressive rate action. In this design, the active coils have large wider a large wire diameter and inactive coils have a small diameter.

Later designs of variable rate spring deviate from this old cylindrical shape. These include the truncated cone, the double cone, and the barrel spring. The major advantage of these designs is the ability of the coils to rest or bottom out, within each other without touching, which lessens the amount space needed to store the springs in the vehicle.

Unlike a linear rate spring, a variable rate spring has predicted standard spring rate. Instead, it has an advantage spring rate based on the load of a predetermined spring deflection. This makes it impossible to compare a wear rare rate spring to a variable rate spring. Variable rate springs, however, handle a load up to 30% over standard rate springs in some applications.

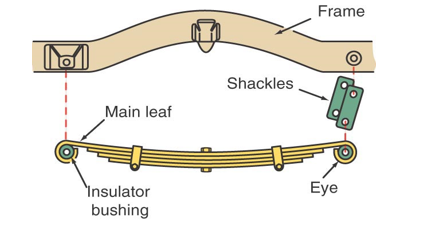
*Servicing Coil Springs.* A technician must know how to check and replace coil springs, select the proper replacement, and recommend the proper size and type of spring to the customer.

The first step in coil spring selection is to check for the original equipment part number. This is usually on a tag wrapped around the coil. In many instances, this tag falls off before replacement is necessary. If a set of aftermarket springs has been installed, the part number might be stamped on the ends of the coil springs have. There are three types of ends use in automotive applications: full wire open, tapered wire closed, and pigtail. Springs with full wire open ends are cut straight off and sometimes flattened or ground into a D or square shape. Tapered wire closed ends are wound to ensure squareness and ground into a taper at the ends. Pigtail ends are wound into a smaller diameter at the ends.

The final step is to check the application in the catalog. To do this, it is necessary to know the make, year, model, body style, and engine size (number of cylinders) and if the vehicle is equipped with air-conditioning. In some cases, it is also good to know the type of transmission, seating capacity, and other specifics that add extra weight to the vehicle. In most catalogs, springs are listed by vehicle application in two sections: front and rear.

**Leaf Spring** Although leaf springs were the first type of suspension spring used on automobiles, today they are generally found only on light-duty trucks, vans, and some passenger cars. There are three basic types of leaf springs: multiple leaf, monoleaf, and fiber composite.

*Multiple-Leaf Spring.* **Multiple-leaf**  spring consist of a series of flat steel leaves that are bundled that are bundled together and held with clips or by a bolt placed slightly ahead of the center of the bundle **(Figure 43-4).** One leaf, called the **main leaf,**  runs the entire length of the spring. The next leaf is a little shorter and attaches to the main leaf. The next leaf is shorter is yet shorter and attached to thes second leaf, and so on. This system allows almost any number of leaves be used to support the vehicle’s weight **(Figure 43-5).** It also gives a progressively stiffer spring. The spring easily flexes over small distances for minor bumps. The farther the spring is deflected, the stiffer it sets. The more leaves and the thicker and shorter the leaves, the stronger the spring flexes. It must be remembered that as the spring flexes, the ends of the leaves slide over the another. This sliding could be a source of noise and can also produce friction. These problems are reduces by interleaves by zinc and plastic placed between the spring’s leaves. As the multiple leaves slide, friction produces a harsh ride as the spring flexes. This friction also dampens the spring motion.

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**Figure 43-4** A leaf spring and its related hardware.



**Figure 43-5** To provide more ground clearance, a kit that included ten leaf rear was installed on this pickup.

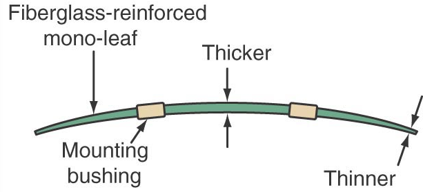
Multiple-leaf springs have a curve in them. This curve, if doubled, forms an ellipse. Thus, leaf springs are sometimes called semielliptical or quarter-elliptical. The semi or quarter refers to how much of the ellipse the spring actually describes. The vast majority of leaf springs are semielliptical.

Leaf springs are commonly mounted at right angles to the axle. In addition to absorbing blows from road forces, they also serve as suspension locators by fixing the position of the vehicle with respect to the front and rear of the vehicle. A centering pin is frequently used to ensure that the axle is correctly located. If a spring is broken or misplaced, the axle might be mix located and the alignment impaired.

The front eye of the main leaf at either end of the axle is attached to a bracket on the frame of the vehicle with bolt and brushing connection. The rear eye of the main leaf is secured to the frame with a shackle, which permits some force and aft movement in response to physical forces of acceleration, deceleration, and braking.

*Monoleaf Springs.* **Monoleaf**or single-leaf springs are usually the tapered plate type with a heavy or thick center section tapering off at both ends. This provides a variable spring rate for a smooth ride and good load-carrying ability. In addition, single-leaf springs do not have the noise and static friction characteristics if multiple-leaf springs.

*Fiber Composite Springs.* While most leaf springs are still made of steel, **fiber composite** types are increasing in popularity **(Figure 43-6).** Some automotive people call them plastic springs in spite of the fact that the springs contain no plastic at all. They are made of fibreglass, laminated and bonded together by tough polyester resin and bundled together by wrapping (a process called filament winding) or squeezed together under pressure (compression molding).

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**Figure 43-6** The construction of a fiber glass reinforced monoleaf spring.

Fiber composite leaf springs are incredibly light-weight and possessed some unique ride control characteristics. Conventional monoleaf steel springs are real 45 pounds (11-20 kg) apiece. Some multiple-leaf can weight almost as twice as much. A fiber composite leaf spring is a featherweight by comparison, weighing merely 8 to 10 pounds (3.6 to 4.5 kg). As every performance enthusiast knows, springs are dead weight. Reducing the weight of the suspensionnot only reduces the spring mass of the suspension itself. This reduces the spring effort and amount of shock control that is required to keep the wheels in contact with the road. The result is a smoother riding, better handling, and faster responding suspension, which is exactly the sort of thing every performance enthusiast wants.

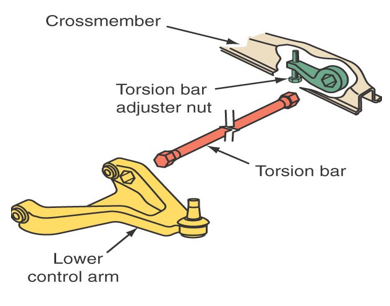
**Air springs** Another type of springs, an air spring is used in an air-operated microprocessor-controlled system that replaces the conventional coil springs with air springs to provide a comfortable ride and automatic front and rear load levelling. This system , fully describe later in this chapter, uses four air springs to carry the vehicle’s weight. The air springs are located in the same positions where coil springs are usually found. Each spring consist of a reinforced rubber bag pressurized with air. The bottom of each air bag is attached to an inverted pistonlike mount that reduces the interior volume of the air bag during jounce **(Figure 43-7).** This has the effect of increasing air pressure inside the spring as it is compressed, making it progressively stiffer. A vehicle equipped with an electronic air suspension system able to provide a comfortable street ride, about a third softer than conventional coil springs. At the time, its variable spring rate helps absorbs bumps and protect against bottoming.



**Figure 43-7** A rear suspension setup with air springs.

**Torsion Bar Suspension System**

**Torsion bars** serve the same function as coil springs. Infact, they are often describe as straightened-out coil springs. Instead of compressing like coil springs, a torsion bar twist and straightens out on the recoil. That is, as the bar twists, it resist up-and-down movement. One end of the bar –made of heat-treated alloy spring steel-is attached to the vehicle frame. The other end is attached to the vehicle frame. The other is attached to the lower control arm **(Figure 42-8).** When the wheel moves up and down, the lower control arm is raised and lowered. This is twists the torsion bar, which causes it to absorb road shocks. The bar’s natural resistance to twisting quickly restores it to its original position, returning the wheel to the road.



**Figure 43-8** A torsion bar setup

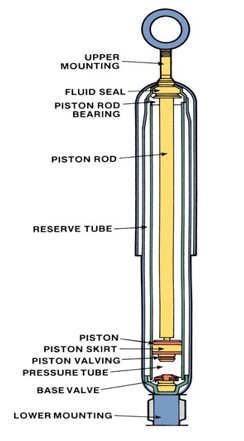
When torsion bars are manufactured, they are pressed to give them fatigue strength. Because of directional prestressed to give them fatigue strength. Because of directional prestressing, torsion bars are directional. The torsion bar is marked either right or left to identify on which side it is to be used.

Because the torsion bar is connected to the lower control arm, the lower ball joint is the load carrier. A shock absorber is connected between the lower control and the lower arm and the frame to damp the twisting motion of the torsion bar.

**Shock Absorbers**

Shock absorbers damp or control motion in a vehicle. If understrained, springs continue expanding and contacting after a blow until all the energy is absorbed. Not only would this lead to a rough and unstable-perhaps uncontrollable-ride after consecutive shocks, it would also create a great deal of wear on the suspension and steering systems. Shock absorbers prevent this. Despite their name, they actually dampen spring movement instead of absorbing shock. As a matter of fact, in England and almost everywhere else but the United States, shock absorbers are referred to as **dampers.**

Today’s conventional shock absorber is a velocity sensitive hydraulic damping device. The faster it moves, the more resistance it has to the movement **(Figure 43-9).**  This allows it to automatically adjust to road conditions. A shock absorber works on the principle of fluid displacement on both its compression (jounce) and extension (rebound) cycles. A typical car shock has more resistance during its extension cycle than its compression cycle. The extension controls motions of the vehicle body’s spring weight. This motion energy is converted into heat energy and dissipates into the atmosphere.



**Figure 43-9** A cross section of a conventional shock absorber.

Shock absorbers can be mounted either vertically or at an angle. Angle mounting of shock absorbers improves vehicle stability and dampens accelerating and braking torque.

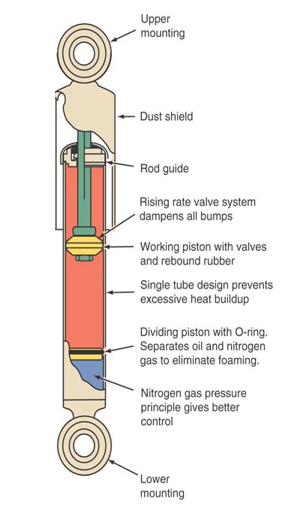
Conditional hydraulic shocks are available in two styles: single-tube and double-tube. The vast majority of domestic shocks are double tubed. The double-tube shock has an outer tube that completely covers the inner tube. The area between the tubes is the oil reservoir. A compression valve at the bottom of the inner tube allows oil to flow between the two tubes. The piston moves up and down inside the inner tube.

In a single **monoshock,** there is a second floating piston near the bottom of the tube. When the fluid volume increases or decreases, the second piston moves up and down, compressing the reservoir. The fluid does not move back and forth between a reservoir and the main chamber. There are no other valves in a single-tube shock besides those in the main piston. The second piston prevents the oil from splashing around too much and getting air bubbles in it. Air in the shock oil is detriminal. Air, unlike oil, is compressible and slips past the piston easily. When this happens, the result is a shock that offers poor vehicle control on bumpy roads.

In addition to these conventional hydraulic shocks, there are a number of others the technician may encounter.

**Gas-Charge Shock Absorbers** On the roads, the passage of fluid from the chamber to chamber becomes so rapid that foaming can occur. Foaming is simply the mixing of the fluid with any available air. Since aeration can cause skip in the shock’s action, engineers have sought methods of eliminating it. One is the spiral grove reservoir, the shape of which breaks up bubbles. Another is a gas-filled cell or bag (usually nitrogen) that seals air out of the reservoir so the shock fluid can only contact the gas.

A gas-charged absorber **(Figure 43-10)** operates on the same hydraulic fluid principle as conventional shocks. It uses a piston and oil chamber similar to other shock absorbers. Instead of a double tube with a reserve chamber, it has a chamber. The coils chamber contains as special hydraulic oil, and the gas chamber contains either freon or nitrogen gas under pressure equal to approximately 25 times atmospheric pressure.



**Figure 43-10** Gas-pressure damped shocks operate like conventional oil-filled shocks. Gas is used to keep oil pressurized, which reduces oil foaming and increases efficiency under severe conditions.

As the piston rod moves downward in the shock absorber, oil s displaced, just as it is in a double-tue shock. This oil displacement causes the divided piston to press on the gas chamber. The gas is compressed and the chamber reduces in size. When the piston rod returns the gas pressure returns the dividing piston to its starting piston. Whenever the static pressure of the coil column is held at approximately 100 to 360 psi (690 to 2.482 kPa) (depending on the design), the pressure decreases behind the piston and so cannot be high enough for the gas to escape from the oil column. As a result, a gas-filled shock absorber operates without aeration.

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**Air Shock Systems** There are two basic adjustable air shock systems: manual fill and automatic load-leveling. The manual fill system can be ordered on new vehicles or can be installed on almost any vehicle manufactures without it.

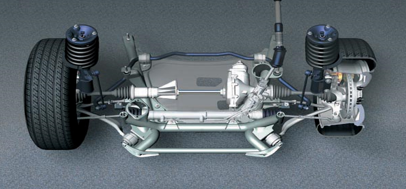
There are several different types of manual fill air shock systems available. One common manual fill air shock system uses a high-speed, direct current (DC) motor to transfer a command signal that is manually selected form the driver’s seat. In another manual air system, the units are inflated through air valve mounted at the rear of the vehicle. Air lines rum between the shocks and the valve. A tire air pressure pump is used to fill the shocks to bring the rear of the vehicle to the desired height.

**Shock Absorber Ratio** Most shock absorbers are valve to offer roughly equal resistance to suspension movement upward (jounce) and downward (rebound). The proportion of a shock absorber’s ability to resist these movements is indicated by a numeric formula. The first number indicates jounce resistance. The second indicates rebound resistance. For example, passenger cars with normal suspension requirements use shock absorbers valued at 50/50 (50% jounce/50% rebound). Drag racer, on the other hand, use shock valued at about 90/10. Small vehicles, because of their light weight and soft springs, require more control in both jounce and rebound in the shock absorbers. Damping rates within the shock absorbers are controlled by the size of the piston, the size of the orifices, and the closing force of the valves.

It is important to keep in mind that the shock absorber ratio only describes what percentage of the shock absorber’s total control is compression and what percentage is extension. Two shocks with the same ration differ in their control capacity. This is one reason the technical must be sure correct replacement shocks are installed on the vehicle.

**MACPHERSON STRUT SUSPENSION COMPONENTS**

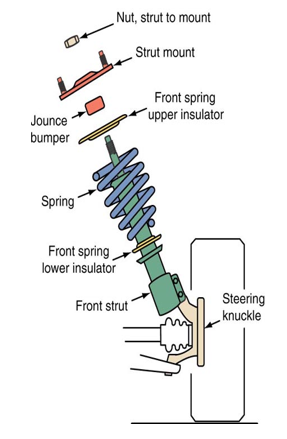
The MacPherson strut suspension is dramatically different in the appearance from the traditional independent front suspension **(Figure 43-11),** but similar components operate in the same way to meet suspension demands.



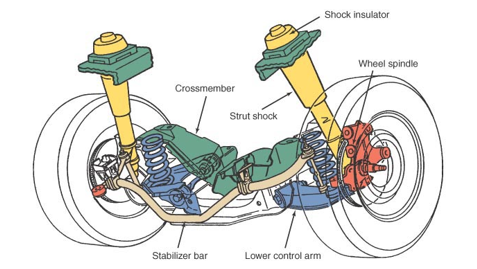
**Figure 43-11** A complete MacPherson strut front suspension.

The MacPherson strut suspension’s most distinctive feature is the combination of the main elements into a single assembly. It typically includes the spring, upper suspension locator, and shock absorber. It is mounted vertically between the top arm of the steering knuckle and the inner fender panel.

Struts have taken two forms: a concentric coil spring around the strut itself **(Figure 43-12)** and spring located between the lower control arm and the frame **(Figure 43-13).** The location of the spring on the lower control arm, not on the strut as in a conventional to be absorbed through the chassis rather than be fed back to the driver through the steering system. This system is called modified MacPherson suspension.



**Figure 43-12** A MacPherson strut with a replaceable shock absorber cartridge.



**Figure 43-13** A modified MacPherson suspension has the spring mounted separately from the strut.

**Struts**

The core element of this type suspension is the strut. With its cylindrical shape and protruding piston rod, it looks quite similar to the conventional shock absorber. In fact, the strut provides the damping function f the shock absorber, in addition to serving to locate the spring and to fix the position of the suspension.

The shock-damping function is accomplished differently on various types of struts. None of them uses a separate shock absorber as the traditional front suspension does. Some version are designed so the damper can be independently serviced.

Struts fall into two broad categories: sealed and serviceable units. A sealed is designed so the top closure of the strut assembly is permanently sealed. There is no access to the shock absorber cartridge inside the strut housing and no means of replacing the cartridge. Therefore, it is necessary to replace the entire strut unit. A serviceable strut is designed so the cartridge inside the housing, which will provide the shock-absorbing function, can be replaced with a new cartridge. Serviceable struts use a treaded body nut until in place of a sealed cap to retain the cartridge.

The shock absorber device inside a serviceable a strut is generally wet. This means the shock absorber contains oil that contacts and lubricates the inner wall of the strut body. The oil is sealed inside the strut by the body nut. O-ring, and piston rod seal. Servicing a wet strut with the equivalent components involves a thorough cleaning of the inside of the body, absolute cleanliness, and great care in reassembly (including replenishing the strut with oil).

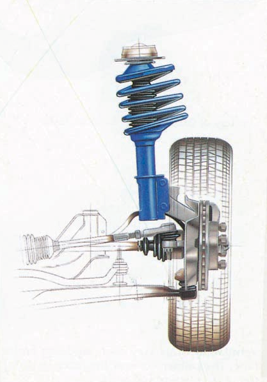
Cartridge inserts were developed to simply servicing wet struts. The insert is a factory-sealed replacement for the strut shock absorber. The replacement cartridge is simply substituted for the original shock absorber cartridge and retained with the body nut.

Most OE domestic struts are serviced by replacement of the entire unit. There are strut cartridge to replace. Sealed OE units can also be serviced by replacement with an aftermarket unit that permits future servicing by cartridge replacement.

The use of the strut reduces suspension space and weight requirements. By mounting the bottom of the strut assembly to the steering knuckle, the upper control arm and ball joint of the traditional suspension are eliminated. In place of the ball joint, the upper mount, which is bolted to the fender panel, is the load-carrying member on MacPherson suspensions.

**Lower Suspension Components**

The suspension’s lower mounting position continues to be the frame, as on the traditional, suspension, because the lower control arm and ball joint are retained **(Figure 43-14).** As on those suspensions, the control arm serves as the lower locator for the suspension.



**Figure 43-14** A front MacPherson strut assembly.

MacPherson strut suspensions continue to use sway or stabilizer bars. On models with single-bushing control arms, **strut rods** or the way bar can be fastened to the control arm to provide lateral stability.

The lower **ball joint** is a friction or steering ball joint and is used to stabilized the steering and to retard shimmy. The only exception is on modified McPherson suspensions. In this design, the ball joint becomes the load bearer; the upper mount becomes the steering component.

**Springs**

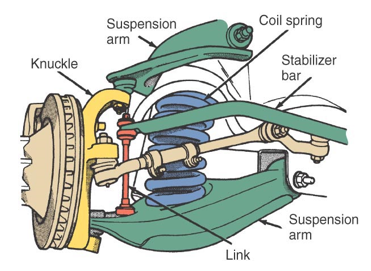
Coil springs are used on all strut suspensions. A mounting plate welded to the strut serves as the lower spring seat. The upper seat is bolted to the strut piston rod. A bearing or rubber bushing in the upper mount permits the springs and strut to turn with the motion of the wheel as it is steered.

**INDEPENDENT FRONT SUSPENSION**

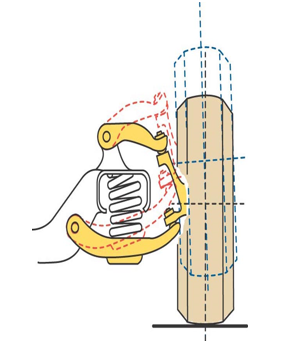
Front-suspension systems are fairly complex. They have somewhat contradictory jobs. They must keep the wheels rigidly positioned and at the same time allow them to steer right and left. In addition, because of weight transfers during braking torque. While accomplishing this, this must good ride and stability characteristics.

**Short –Long Arm Suspension**

The unequal length control arm or **short-long arm (SLA)** suspension system has been common on domestic-made vehicles for many years **(Figure 43-15).** Each wheel is dependently connected to the frame by a steering knuckle, ball joint assemblies, and short upper and longer lower control arms. Because the upper arm pivots in a shorter arc, the top of the wheel moves in and out slightly but the tire’s road contact remains constant **(Figure 43-16).**

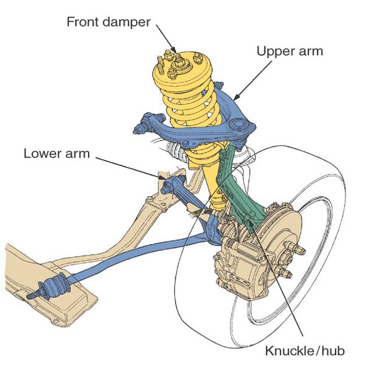


**Figure 44-15** A typical SLA front suspension.



**Figure 43-16**The movement of the wheel as a wheel as short-long arm suspension system moves up and down

One design of an SLA uses a narrow lower control arm, shaped an “I” **(Figure 43-17).** A strut rod id attached to the control arm in place. The strut rod is used to hold the close to the steering knuckle and to the frame in front of the wheel assembly. Rubber bushings at the frame mounting allow the strut rod to move a little when the tire hits a bump. The bushing dampens the shock and prevents it from transmitting through the vehicle’s frame.

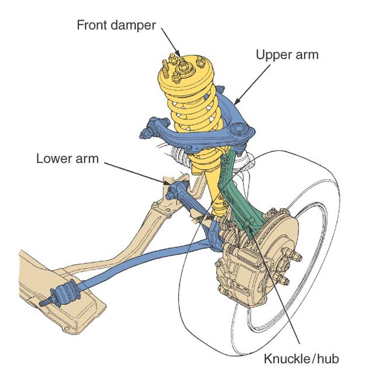


**Figure 44-17** A FWD wishbone suspension system with a narrow lower control arm on a single pivot.

The essential components of SLA systems are the wheel spindle assembly, control arms, ball joints, shocks absorbers, and spring, among others.

**Wheel Spindle** A **wheel spindle** Assembly consist of a wheel spindle and a steering and a steering knuckle. A wheel spindle is connected to the wheel through wheel bearings and is the point at which the wheel hub and wheel bearings are connected. a **Steering knuckle** is connected to control arms. in most cases, a steering knuckle and wheel spindle are forged to a single piece.

**Control Arms** The upper and lower **control arms** on the traditional **independent front suspension (IFS)** function primarily as locators. They fix the position of the system and its components relative to the vehicle and are attach to the frame with bushings that permit the wheel assemblies to move up and down separately in response to irregularities in the road surface. They outer ends are connected to the wheel assembly with ball joints **(Figure 42-18)** inserted through each arm into the steering knuckle.



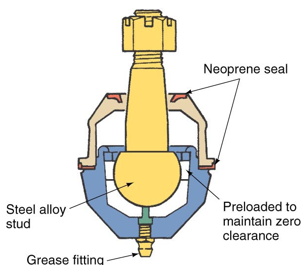
**Figure 43-18** Ball joint locations

There are two types of control arms; the wishbone, or double-pivot, control arm and the single-bushing, control arm **(Figure 43-19).**  The wishbone offers greater lateral stability than the single –pivot arm, which is lighter and requires less space than the wishbone but also requires modifications in suspension design to compensate for the reduced lateral stability. Those modifications are discuss further later in this chapter.



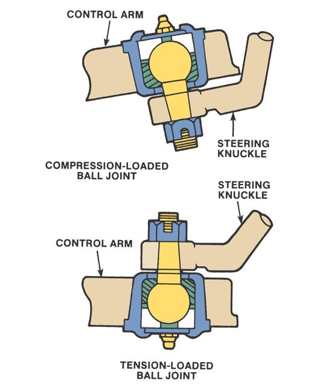
**Figure 43-19** A front suspension system with an upper control shaped like wishbone, which is what this type of suspension is called.

**Ball Joints** A ball joint **(Figure 43-20)** connects the steering knuckle to the control arm, allowing it to pivot on the control arm during steering. Ball joint stud protrudes from its sockets through a rubber seal that keeps lubricating grease in the housing and keeps dirt out. Some balls require periodic lubrication, while most do not**.** These maintenance-free ball joints move in a prelubricated nylon bearing.



**Figure 43-20** A typical ball joint.

Ball joint are either load a load carrying or are followers. A load-carrying ball joint support the car’s weight and is generally in the control arm that holds or seats the springs. Load-carrying joints can be called tension-loaded or compression-loaded ball joints **(Figure 43-21).** The correct term depends on whether the force of the load tends to push the ball into the sockets (compression) or pull it out of the socket (tension).

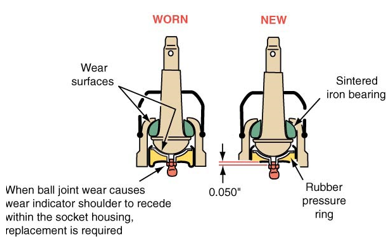


**Figure 43-21** Two basic types of load-carrying ball.

Follower ball joints are often called friction-loaded ball joints. A followed ball joint mounts on the control arm that does not provide a seat for the spring. The follower does not support vehicle weight and does not get the same stress as the load carrier.

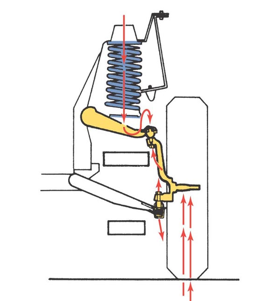
Depending on the location of the suspension system’s spring, either the upper or lower ball joint will be the load-carrying joint. In a MacPherson strut suspension, there is usually only one ball joint on each side and it is typically a follower. In modified strut suspensions, the ball joint is a load-carrying because the spring is positioned between the frame crossmember and the lower control arm.

Some ball joints have wear indicators. As the joint wears, the grease fitting of the joint recedes into the housing. When the shoulder of the fitting is flush with the housing, the joint needs to be replaced **(Figure 43-22).**

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**Figure 43-22** A wear indicator on a ball joint.

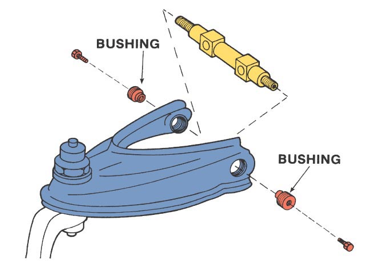
A ball joint is nothing more than a ball-in-socket joint. As long as ball is firmly in the socket joint. As long as is firmly on the socket, and the ball and/or socket is not worn, the joint will provide a solid connection. Once the ball or socket is worn, the connection becomes sloppy. How the ball is kept in its socket depends on the type of ball joint it is. Load-carrying ball joints rely on the vehicle weight to keep the ball in the socket **(Figure 43-23).** As the weight is removed from the joint, the ball relaxes in the socket and will feel loose. Follower ball joints are held in place by friction inside the joint. A spring inside the joint typically keeps the ball tight in the socket but allows for some flexibility. This type of joint should never have any play.



**Figure 43-23** The upper ball joint is the load-carrying joint in this system because of the position of the spring.

**Other Front System Components** In addition to shock absorbers, other suspension control devices include bushings, stabilizer or sway bars, and strut rod. In the design of these suspension control devices, the difference between sprung and unsprung weight is important.

*Bushings.* Rubber or polyurethane bushings are found on many suspension components, such as the contol arms **(Figure 43-24),**  radius arms, and strut rods. They make good suspension system pivots, minimize the number of lubrication points, and allow for slight assembly misalignments. Bushings help to absorb road shock, allow some movement, and reduce noise entering the vehicle.



**Figure 43-24** Control arm bushings.

Suspension bushings can deteriorate fairly rapidly, causing tire wear. They are a common cause misalignment. Replacement bushings come in two basic varieties: stock and performance. The latter are usually made of a high grade polyurethane material and are sold primarily as an upgrade to improve handling response and ride control.

The harder urethane bushings eliminate unwanted compliance or given in the suspension. When hard cornering overtaxes stock bushings and causes them to deflect excessively, undesirable chamber changes occur in the front wheels that result in excessive outer shoulder wear on the tires. Compliance also slows down the action of the sway bar when the cornering, which has a significant impact on the vehicle’s road holding ability and steering stability (especially in cross winds). Firmer bushings can also help reduce torque steer in front-wheel-drive cars. Torque steer is the tendency to pull to one side (usually to the right) under hard acceleration. It is more of a problem on FWD cars with the shorter shaft (usually the left side) gets more torque than the one with the longer shaft. There is enough give in the suspension that the left wheel tries to pull ahead of the right, throwing wheel alignment off enough to make the car to the right.

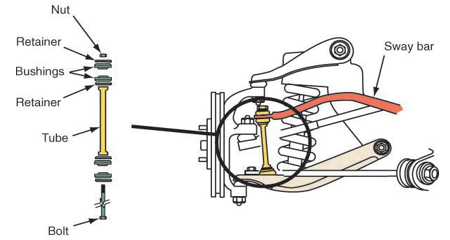
The procedures for checking bushing and the methods for replacing them are given service manuals.

*Stabilizers.* A variety of devices are used with the basic suspension components to provide additional stability. One of the most common if the **sway bar**, which is also known as the **antisway bar** or stabilizer. This is a metal rod running between the opposite lower control arms. As the suspension at one wheel responds to the road surface, the sway bar transfers a similar movement to the suspension at the other wheel. For example, if the right wheel is drawn with it creating a downward draw on the left wheel as well. In this way, a more level ride is produces. Sway or lean during cornering is also reduced.

If both wheels go into a jounce, the sway bar simply rotates in its insulator bushings. It is a different matter when only one wheel goes into jounce. The stabilizer bar twists, just like a torsion bar, to lift the frame and the opposite suspension arm. This action reduces body roll.

the sway bar can be a one-piece, U-shaped rod fastened directly into the control arm by a separate sway bar link. The arm is held to the links with nuts and rubber bushings and is also mounted to the frame in the center with rubber bushings. If the sway bar is too large, it causes the vehicle to wander. If it is too small, it has little effect on stability.

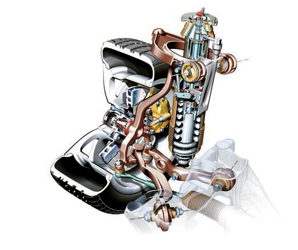
On suspensions that use single-housing lower control arms instead of wishbone types, the sway bar can also be used to add lateral stability to the control arm. Strut rods are used on models that do not use the sway bar like this. They are attached to the arm and frame with bushings, allowing the arm a limited amount of forward and backward movement **(Figure 43-25).** Strut rods are directly affected by braking forces and road shocks, and their failure can quickly lead of the entire suspension system.



**Figure 43-25** The strut bar assembly for attaching the sway bar control.

**Four-Link Front Suspension**

A four-link front suspension fixes the wheel with four rod-type control arms and the tire rod **(Figure 43-26).**  The suspension strut supports the vehicle weight against the body via the load-bearing link. By separating wheel attachment and suspension elements, this suspension optimizes ride quality and movement. The influence of drive forces on the steering system is minimal.



**Figure 43-26** A four-link front suspension system**.**