Truck Radial Tire Service

1. Tire Wear and Probable Causes:

1. Alternate lternate lug wear
2. Rib punch wear
3. Feather edge wear
4. Both shoulder wear
5. Brake skid or flat spot wear
6. Spotty wear
7. Cuppy wear
8. Diagonal wear
9. Erosion / river wear
10. One sided wear
11. Shoulder scrubbing / scuffing wear
12. Shoulder step / chamfer wear
13. Heel and Toe Wear

1.1 ALTERNATE LUG WEAR

Whats Happening:
The tires's lugs are not wearing consistently because they are not making uniform contact with road.

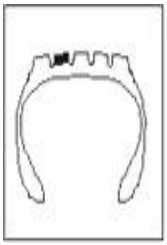


Probable Causes:
- Mismatched Duals
- Inconsistent dual inflation (> 10 PSI)
- Tread design/Tyre design

1.2 RIB PUNCH WEAR

What's Happening:
The worn areas are scrubbing the highway because the tread area is distorting in the footprint.

Probable Causes:
Lack of shock absorber control in some suspension types, mismatched tire sizes



and/or inflation pressures, loose or worn bearings, assembly non-uniformity such as improper bead seating and out-of-balance condition, aggravated by high speed empty hauls.

Corrective Action

Probe the casing in the tread area and feel the liner for separation. If you have many tyres with rib punch, consider a different tyre manufacturer, tyre series or tread design.

What to do with the tire:

Remove tyre from service and send it for retread consideration.

1.3 FEATHER EDGE WEAR

What's happening

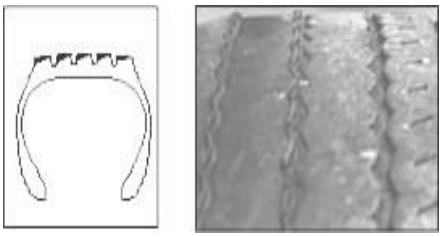
The tyre is not tracking straight down the highway, but is cocked slightly to the side.

Probable Causes:

Vehicle misalignment

Corrective action

- If sharp edges on both steer tires are pointed to the centre of the vehicle, the cause is toe in.
- If the sharp edges on both steer tyres are pointed toward the outsude if the vehicle, the cause is toe out. correct alignment.
- If sharp edges point in on one tire and out on the other tyre, the cause is rear axle misalignment. Correct alignment.
- If only one of the steer tyres has feather edge wear, the cause is a combination of incorrect toe and rear axle misalignment. correct both drive or trailer tires.



- Align axle perpendicular to frame rail and parrallel to other axles.

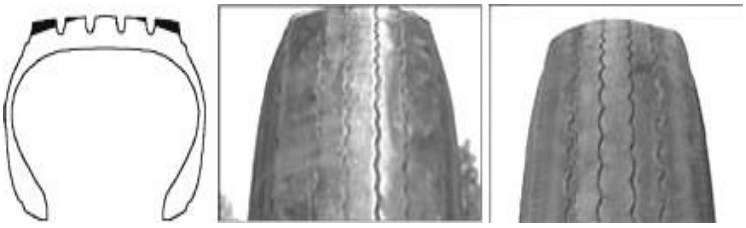
What to do with the tyre

Continue to run tyre. When worn area reaches tread wear indicators, and retread the tyre.

1.4 BOTH SHOULDER WEAR

What's happening

The tread is not making flat contact with the highway. The outer portions of the tread are carrying most of the load because the tyre is underinflated for the load.



Probable causes:

Inflation pressure and load

Corrective action

Refer to tyre manufacturer's load and inflation table for recommended inflation pressure at the speeds the tire will operate.

Establish a fleet standard inflation and maintain tyre inflation to fleet standard.

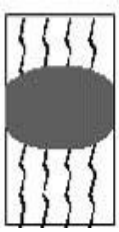
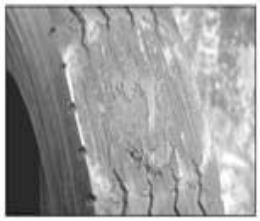
What to do with the tire

Because this tyre has run underinflated for the load, it may have been damaged internally. Running underinflated can lead to zipper rupture, a very dangerous tyre condition. use extreme caution in handling this tyre.

If tyre inflation pressure is less than 80 per cent of fleet standard, deflate the tyre by removing the valve core, then remove tyre and wheel (or rim) assembly from vehicle.

demount tyre. Inspect the tyre for evidence of run flat damage and, if none is found, to retread tyre.
If tyre inflation pressure is over 80 per cent of fleet standard, inflate (or deflate) tyre to fleet standard and continue to run it. When worn area reaches tread wear indicators, retiread the tyre.

1.5 BRAKE SKID OR FLAT SPOT WEAR


What's happening

The tyre slid across the road surface, scuffing away the tread in one area. This generally happens as a result of brakes locking up due to brake malfunction or the driver aggressively applying the brakes in an emergency situation. Flat spotting can also occur if the tire sat in oil, fuel or chemicals.

Probable causes

- Brake lock due to malfunction or unbalanced brake system
- Aggressive brake application
- Tire sitting in oil, fuel or chemicals

Corrective action

Look for scratches and directional abrasion in and near the flat spot. If you find them, the flat spot is due to brake lock. You will find similar abrasion on the mated dual. Check the dual tyres on the opposite end of the axle. If they don't have similar flat spots, only one brake locked, indicating a single brake problem. Correct the brake problem. If you find softened or discolored rubber adjacent to the flat spot, chances are the tire sat in oil, fuel or chemicals. Avoid allowing tyres to sit in such materials.

What to do with the tire

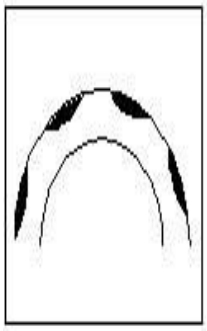
Tire must be removed from service. If a tire with a flat spot is mated with a normal tire, the normal tire will also develop a flat spot. repair the damage or retread the tyre. If damage is deeper than the top of the belt package, the tyre must be scrapped.

1.6 SPOTTY WEAR

Probable causes

- Loose wheel bearings
- Mismounted tyre /wheel assembly
- Worn bearings, shocks, springs or other suspension components
- Mismatched duals
- Inconsistent dual inflation
- Out of balance wheel assembly
- Brake lock due to malfunction or unbalanced brake system
- Aggressive brake application
- Tyre sitting in oil, fuel or chemicals

1.7 CUPPY WEAR



What's happening

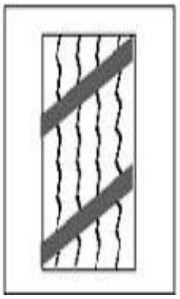
The tyre is not tracking straight down the highway, but is bouncing sideways during rotation. It may be wobbling on the axle or rim. On trailers, the condition is aggravated by running empty. Because of the light load, the trailer begins to bounce, creating more irregular wear, which creates more bouncing, the bouncing can create vehicle suspension component wear.

Probable causes

- Loose wheel
- Mismounted tire/ wheel assembly
- Out of balance wheel assembly
- Tread design/ tire design
- Worn bearings, shocks, springs or other suspension components
- Mismatched duals
- Inconsistent dual inflation (10 PSI or greater)

1.8 DIAGONAL WEAR

Corrective action

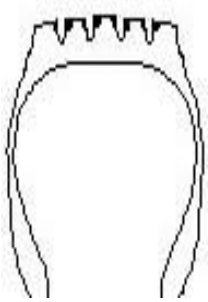
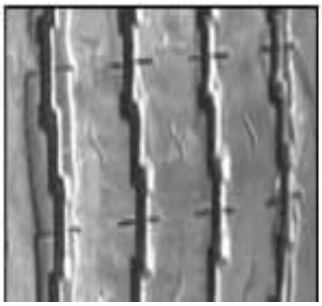


Tighten wheel bearings. check wheel assembly for proper mounting of tyre on wheel (or rim) and for proper mounting of axle. If you have many tyres of the same tire brand and tread design with cupping/scallop wear, test other tyre brands, tyre series or tread designs. match duals by the tyre brand, size and series (differences no more than 1/4" in overall diameter).inflate tires to fleet standard.

What to do with the tire

Continue to run tyre. When worn area reaches tread wear indicators, retread the tyre.

1.9 EROSION / RIVER WEAR

What's happening

the tyre is not tracking straight

down the highway. but is bouncing slightly sideways during parts of its rotation. it may be wobbling on the axle or rim. on trailers, the condition is aggravated by running empty. because of the light load, the trailer begins to bounce, creating more irregular wear, which creates more bouncing, and so forth. the bouncing can create vehicle suspension component wear.

Probable causes

- Loose wheel bearings
- Mismounted tire/ wheel assembly
- Out of balance wheel assembly
- Tread design/ tire design
- Worn bearings, shocks, springs or other suspension components
- Mismatched duals
- Inconsistent dual inflation (10 psi or greater)

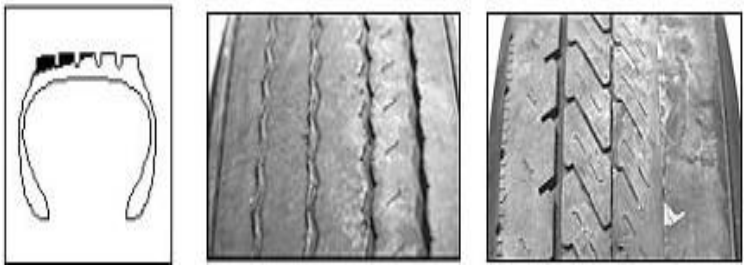
Corrective action

Tighten wheel bearings. Check wheel assembly for proper mounting of tyre on wheel (or rim) and for proper mounting of axle. If you have many tyres of the same tyre brand and tread design with cupping/scallop wear, test other tire brands, tire series or tread designs. Match duals by the tyre brand, size and series (differences no more than 1/4" in overall diameter). Inflate tires to fleet standard.

What to do with the tire

Continue to run tyre. When worn area reaches tread wear indicators, retread the tyre.

1.10 ONE SIDED WEAR



What's happening

this tyre is worn from corrective steering due to vehicle thrust (rear axle misalignment), cocked (toe in or out), tilted (camber) or the axle is bending due to overloading.

Probable causes

- Vehicle misalignment.
-Overloaded axles.

Corrective action

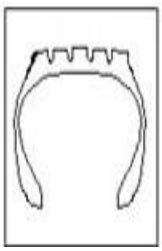
STEER TIRES

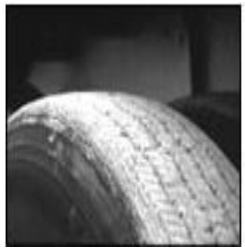
- If one-sided wear is on the inside of one steer tyre and the outside of the other steer tyre, the cause is rear axle misalignment. Correct alignment. If one-sided wear is on the outside of both steer tyres, the cause is either toe in or camber. Check both and correct.
  - if one-sided wear is on the inside of both steer tyres, the cause is either toe out, camber or overloaded axles. Check and correct toe and camber settings. Check load specifications on the axle and keep loads within specs.
- Drive or trailer tires
  - align axle perpendicular to frame rail and parallel to other axles. If the axle is bending, check the load specifications on the axle and keep loads within specs.

  What to do with the tire

  Continue to run tyre. When worn area reaches tread wear indicators, retread the tyre.

1.11 SHOULDER SCRUBBING / SCUFFING WEAR





What's happening

The tyre is being dragged sideways (lateral scrubbing). This is commonly seen in vehicles operating in spread axle or multi-axle configurations and on trailers subjected to tight turning maneuvers.

Probable causes

Lateral Scrub

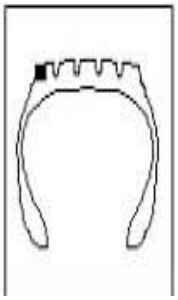
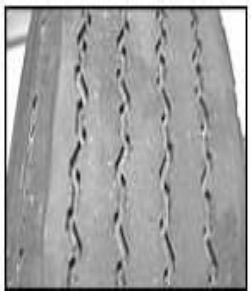
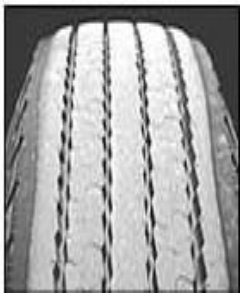
Corrective action

Lateral scrub may be unavoidable for some applications. Some treads are designed to overcome the problem of lateral scrubbing.the retreader can also employ retreading procedures to help overcome the problem of lateral scrubbing.

What to do with the tire

Continue to run tyre if wear has not reached tread wear indicators and scrubbing has not damaged the integrity of the casing. To obtain maximum mileage from the tread, rotate the tyre to a different wheel position. When worn area reaches tread wear indicators, retread tyre.

1.12 SHOULDER STEP / CHAMFER WEAR

What's happening

This condition is typical of certain tire brands and long wearing tread designs. This condition is not linked to any maintenance practices.

Probable causes

This condition is related to tread designs that provide extremely long wear. It is not seen as a major problem since the tread on the tyre is wearing so slowly and the accumulated mileage on the tread will be so great.

Corrective action

Tyres with decoupling grooves appear to have a lower incidence of shoulder step/chamfer wear. If you have many tyres with this condition, consider a tread design with a decoupling groove.

What to do with the tire

Continue to run tyre. When worn area reaches tread wear indicators, retread the tyre.

1.13 HEEL & TOE WEAR



What's Happening

The trailing portion of the lugs are scuffing like a rubber eraser. The lugs are distorting during acceleration or during operation so they are not making flat contact with the highway.

Probable causes

- Mismatched duals
- Inconsistent dual inflation (10 Psi Or Greater)
- Torque dtress
- Tread design/ Tyre design

Corrective action

Match duals by tyre brand, size and series (difference no more than 1/4" in overall diameter).

Inflate tyres to fleet standard. If the tractor has a single drive axle, torque stress may be unavoidable. Also, in some applications, heel/toe wear may routinely develop on certain tread types. The only solution may be a tread design with larger, more stable tread elements or solid outer ribs.

What to do with the tire

Continue to run tyre. When worn area reaches tread wear indicators, retread the tyre. To obtain maximum mileage from the tread, rotate the tyre to a different drive wheel position.

2. Mounting and Demounting

(Refer : Detailed steps by step activites given in : Tyre mounting and demounting Procedure)

SAFETY INSTRUCTIONS LUBRICATION

Do not mount or demount tires without proper training. Wall charts containing mounting and demounting instructions for all on-highway rims should be available through your normal rim supplier.

WHEEL INSPECTION GUIDELINES

Remove any and all cracked wheels from service. Cracked wheels not removed from service will fail.

Inspect wheels for sometimes small cracks emanating from stud holes.

These cracks will continue to grow outward, through the “dish” or between stud holes.

LUBRICATION

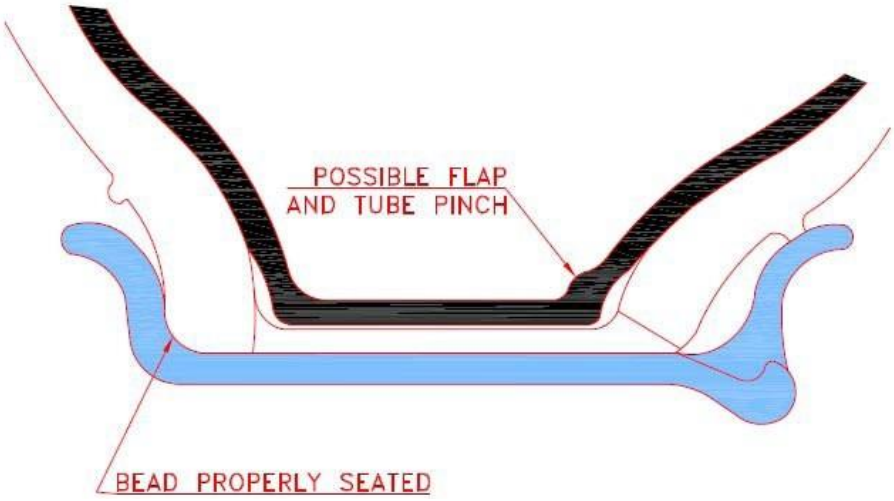
A non-water base commercial bead lubricant should be used since water in the tire can cause excessive rim corrosion problems. However, thin vegetable oil soap solutions with a water base are

approved. Lubricants which contain a rust inhibitor can be an advantage. Avoid the use of excessive lubricants. Never use anti-freeze, silicones or petroleum based lubricants.

When a tube and flap are not properly lubricated before mounting, they will be stretched thin in the tire bead and rim region. This will cause premature failure.

Always use lubricant when mounting radial truck tires to ensure proper bead seating and to prevent eccentric mounting. The more flexible sidewall of the radial tire makes the use of lubricant in the bead area more critical than for bias ply tires which have stiffer sidewalls.

If the bead is not properly seated on either a 2-piece or 3-piece rim and becomes "hung-up," usually on the removable flange side of tube type tires, the lower sidewall area flexes excessively under load, and irregular tread wear and cracking in the lower sidewall bead area often result. Improperly seated beads can also produce severe truck vibration and cause chafing through the lower sidewall down to the wire. When the bead is not properly seated, the bead toe is lifted, and the flap may be forced under the toe. Continued up and down flexing of the toe can cut through the flap. As this process continues, the tube becomes pinched and may fail suddenly.

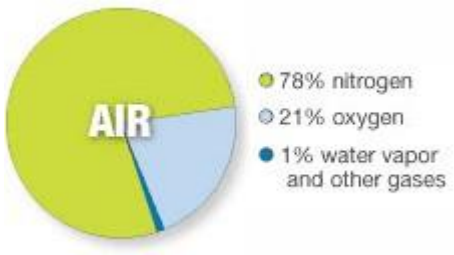


4. Nitrogen Inflation:

What is Nitrogen? Nitrogen is a dry, inert gas used to inflate airplane tires, off-road truck tires, military vehicle tires, and race car tires for improved performance, more tire mileage and better fuel economy.

Why use Nitrogen?

- Less inflation pressure loss
- Reduced wheel corrosion
- Prevents inner-liner rubber deterioration by oxidation
- Tires run cooler
- Increases tread life
- Increases fuel mileage
- Helps prevent uneven wear



The air that we breathe every day contains mostly nitrogen, but it's the rest of the elements that pose a problem for your wheels and tires.

Oxygen in compressed air permeates through the wall of the tire, thus reducing the tire's inflation pressure. During its journey through the tire wall, oxygen oxidizes the rubber compounds in the tire, causing under-inflation and deterioration of the rubber. Dry nitrogen will maintain proper inflation pressure and will prevent auto-ignition, will not corrode rims, extends valve core life, and will help the tire to run cooler.

The biggest advantages - improved tire life

Experts in the tire industry indicate that oxidative aging is one of the primary causes of decreased tire life. Oxidative aging is caused by the diffusion of oxygen from the pressurized air cavity of the tire to the outside atmosphere. Tests have shown that if tires are inflated with nitrogen, there is a significant reduction in tire failure.

Why did race cars, military and off-road vehicles switch to Nitrogen?

Air is about 1/5 Oxygen, and oxygen, especially at high pressures and temperatures, is a very reactive element.
When oxygen reacts with things, the process is called oxidation. When oxidation is extremely rapid, it's called "burning.
That's one reason nitrogen is used in off-highway and aircraft tires. These tires run so hot they can actually catch on fire. Nitrogen doesn't support combustion, so nitrogen-filled tires don't add fuel to the flames. And nitrogen helps prevent slower forms of oxidation also.

Nitrogen prevents other types of corrosion as well

Oxygen and moisture corrodes aluminium and steel wheels. Oxygen also reacts with rubber, another type of "corrosion". When this

corrosion starts, the small particles break off and form rust and dust, which can clog valve cores, causing them to leak. The rough surfaces created from the corrosive action on the wheels leads to tire beads that don't seal properly, causing additional leaks. Oxygen also ages the inner liner, the thin layer of rubber inside the tire whose function is to keep air away from the carcass. As the inner liner ages, more and more air molecules can pass through it, causing more pressure losses. These pressure losses in a truck tire can average 2 psi a month as a result of the air passing through the sidewalls. As it passes through the rubber, the oxygen can also corrode the steel cords, causing them to rust too.

How does Nitrogen help?

While both nitrogen and oxygen can permeate rubber, nitrogen does it much more slowly. It might take 6 months to lose 2 psi with nitrogen, compared to just a month with air. And nitrogen is far less reactive. It doesn't cause rust or corrosion on steel or aluminium, and it doesn't degrade rubber. Wheel surfaces stay smooth and clean, rubber remains supple and resilient.

Nitrogen also will not degrade the rubber seal in the valve core which extends valve core life and helps prevents core leaks.

Small bits of dust and debris as a by-product of oxidative corrosion to the wheels and alloy rims can lodge in the valve core seat, causing air leaks.

Any other reasons for using Nitrogen?

Water!! The air around us is full of water vapour. Compressing air concentrates the water in it. Draining the water from your compressor tank daily helps, but unless you have a really efficient air dryer system, chances are that there's a lot of water in your compressed air.

When you compress air, it takes up much less volume, but the percentage of water by volume is greatly increased..... and what harm does this moisture cause?

Water vapour in compressed air acts as a catalyst, accelerating rust and corrosion. Water vapour also absorbs and holds heat. And when it changes from liquid to vapour, water expands tremendously in volume. As a result, tires inflated with wet air tend to run hotter and fluctuate in pressure more. That's one of the reasons why racing tires, where fractions of a psi can radically change the handling characteristics, are inflated with dry nitrogen.

Will my tires have 100% Nitrogen after they are filled?

In reality the Ingersoll-Rand Nitrogen Generator puts out 98% pure Nitrogen. On an un inflated tire, there is still some air present, so after you refill with nitrogen, you'll end up with about 95% nitrogen, which is enough to do the job. That can be increased slightly by filling up the tire with nitrogen without a valve core in the valve stem, and then letting the tire deflate. Then install the valve core and refill to

normal pressure with the nitrogen.

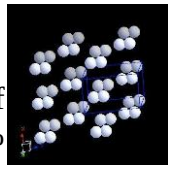
For fleets - reduced operating costs

Tires are one of the primary costs of operating a fleet of vehicles. Tire costs include procurement, maintenance and the cost of blowouts.

A typical truck tire with two retreads costs Rs 7000.00 and lasts approximately 260,000 kms (varies with different applications) .Inflating tires with nitrogen will help to prevent premature casing failure and allow tires to be retread multiple times, with confidence and reliability.

Municipal and corporate fleet managers are looking for innovative ways to cut operating costs while improving overall safety and efficiency. There's never been a more perfect time to look into getting your fleet backed by the power of Nitrogen inflation.

The primary cost of maintaining tires is the cost of labour to check tire pressures and top off tires with compressed air on a periodic basis. Tire pressure must be checked and the tires topped off due to the diffusion of air through the tire. Tires filled with nitrogen will not experience this diffusion and resulting loss of pressure. Tires filled with nitrogen maintain pressure for a much longer period of time than tires filled with air.



Not all nitrogen is the same.

Without proper application and adequate purity nitrogen inflation is of nominal value. Many studies show that a purity level in excess of 95% nitrogen is required for maximum benefits.

Nitrogen isn't necessarily 'good' for your wheels and tires -- it's the lack of corrosive oxygen and water vapour that is truly beneficial. So if tires aren't filled with N2 in excess of 95% pure, they aren't enjoying the real advantages of nitrogen tire inflation in the first place.

5. What is Proper Wheel Alignment?

A properly aligned vehicle is one in which all wheels are aimed in the same direction. Some very low tolerance or acceptable error is designed into each vehicle by the manufacturer (see the vehicle manufacturer specifications).

How Can Wheel Alignment Benefit Your Operation?

The number one and number two operating expenses in over-the-road transportation are fuel and tires respectively. Both are typically perceived as hard to control. Routine wheel alignment is the most effective way to control tire costs and can impact fuel costs as well.

Problems created by misalignment:

- Excessive tire wear
- Increased fuel consumption caused by increased rolling resistance
- Unsafe vehicle handling characteristics

• Driver fatigue and driver retention
• Premature suspension component wear

Between 70 and 80 percent of heavy duty vehicles on the road today are misaligned!

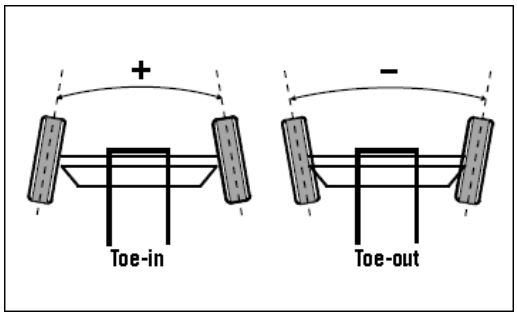
The transportation industry, as a whole, finds that outsourcing timely, accurate alignment service performed by qualified technicians is difficult to manage. As a result alignment is mostly addressed after the damage has been done. Simply making alignment part of a vehicle or fleet preventive maintenance program allows operators to easily get a handle on this perceived uncontrollable expense.

Alignment service is a natural fit for service facilities currently repairing suspensions. Technicians performing repairs on heavy duty suspensions are in effect alignment technicians. The only required equipment is the precision measuring system.

Alignment Angles and Effects

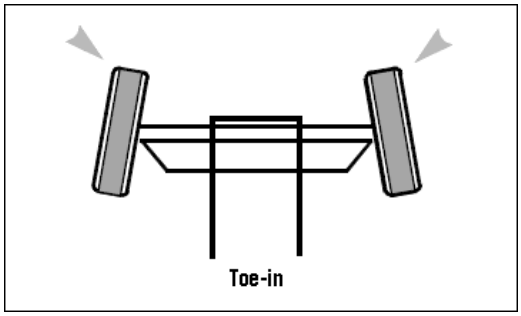
Tire Near Bus to !^P^^P^^ TOP Settings*

Toe is the most critical alignment setting for steer axle tire wear. It is measured in inches, millimeters or degrees.

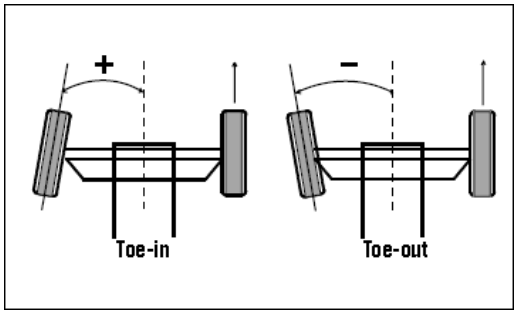


Total Toe is the angle loomed by to hotiZ00td lines through the planes ol two wheels Toe-in is when the hotiZ00tal lines irtetsect inItort ol the vehicle, Toe-out is when the hotiZ00tal lines irtets6Ct behind the wheels.

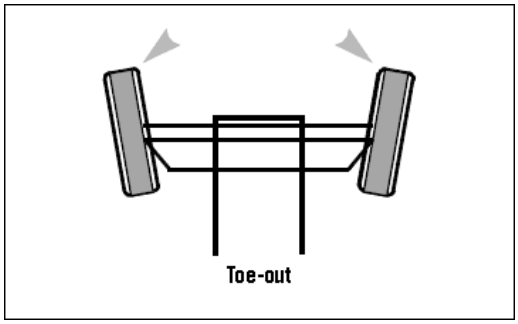
Results of excessive toe is wear on the leading edge of the tire.



Excessive toe-in wears the outside of the tire

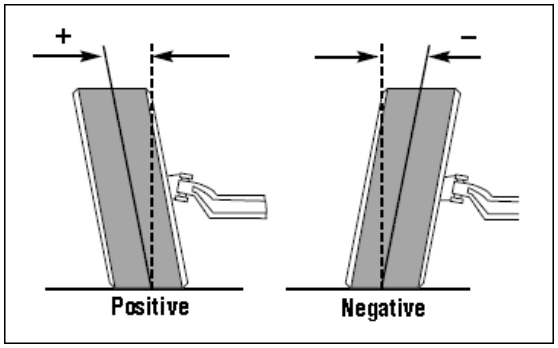


Individual Toe is the angle drawn by a line drawn through a plane of one wheel referenced to the thrust line of the vehicle. Toe-in is when the horizontal lines intersect in front of the wheel. Toe-out is when the lines intersect behind the wheel.

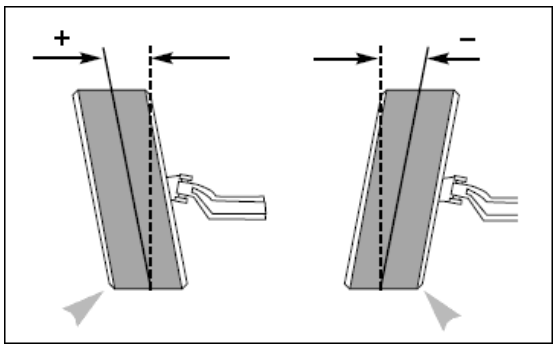


Excessive toe-out wears the inside of the tire

Tire Wear Due to Improper Camber Settings

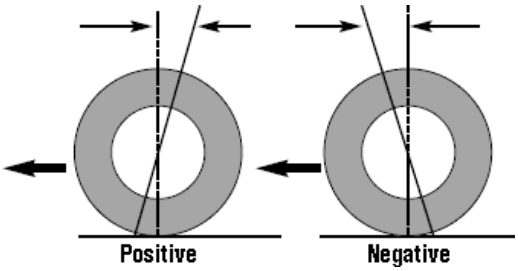


Camber is the angle formed by the inward or outward tilt of the wheel referenced to a vertical line. This angle is measured in degrees. Camber is positive when the wheel is tilted outward at the top and is negative when the wheel is tilted inward at the top.



Tire wear from excessive camber: Wear from positive camber is on the outside shoulder of the tire; with negative camber, wear is on the inside shoulder.

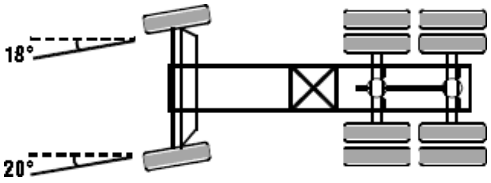
Master: A Factorin Vehicle handling



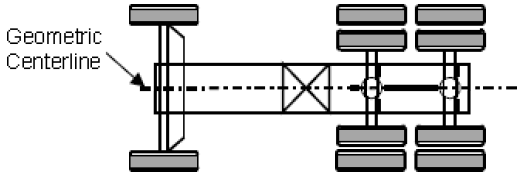
Caster is the forward or rearward tilt of the steering axis in reference to a vertical line. The angle is measured in degrees. Caster is positive when the top of the steering axis is tilted rearwarc and is negative when the tilt is forward. Caster is usually a factor in vehicle handling, but can affect tire wear. Proper caster is important for directiona stability and returnability. Improper caster can cause shimmy, excessive steering effort, pulling and shoulder wear on the steer tires.

Turning Angle

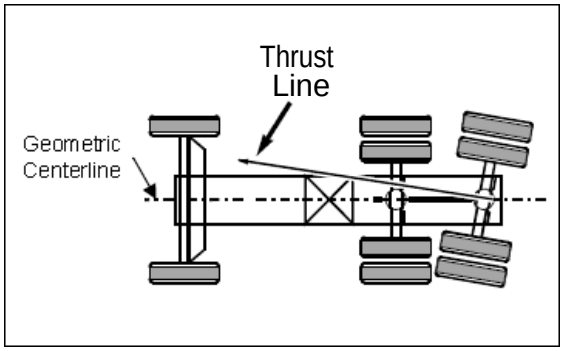
Turning angle is the difference in the angles of the front wheels in a turn. This measurement is a aid in diagnosing steering problems and irregular tire wear. Improper turning angle may cause scuffing, leading to excessive tire wear.



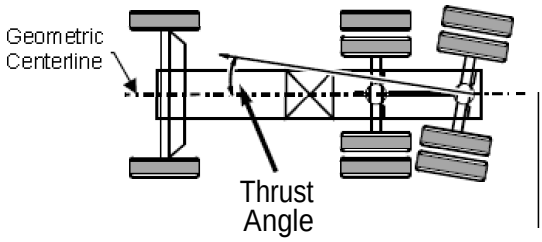
Tandem Lxte Angles



Geometric centerline of a vehicle is a line drawn through the midpoints of the front axle and



Thrust line is the bisector of the total toe angle of an axle. It represents the direction the axle "points" compared to the centerline of the

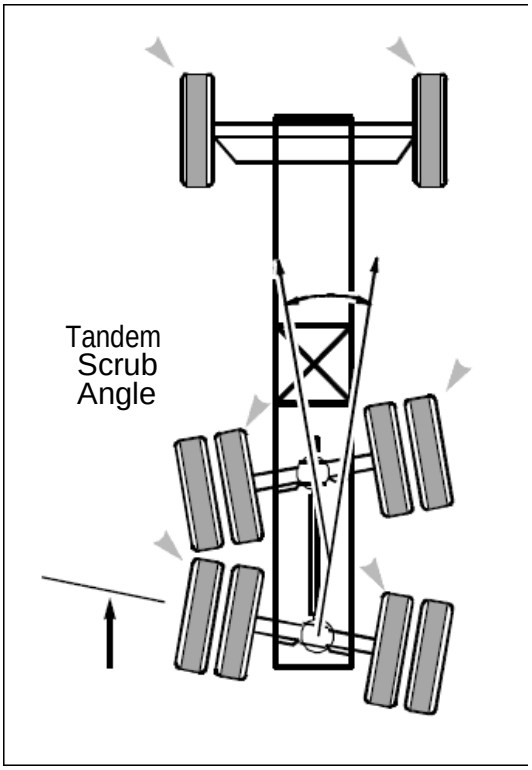


Thrust angle is the angle formed by the geometric centerline and the thrust line of an

Tandem scrub angle is the angle formed by t two thrust lines of a tandem axle vehicle.

In the diagram below, misalignment causes the tandem axles to work against each other.

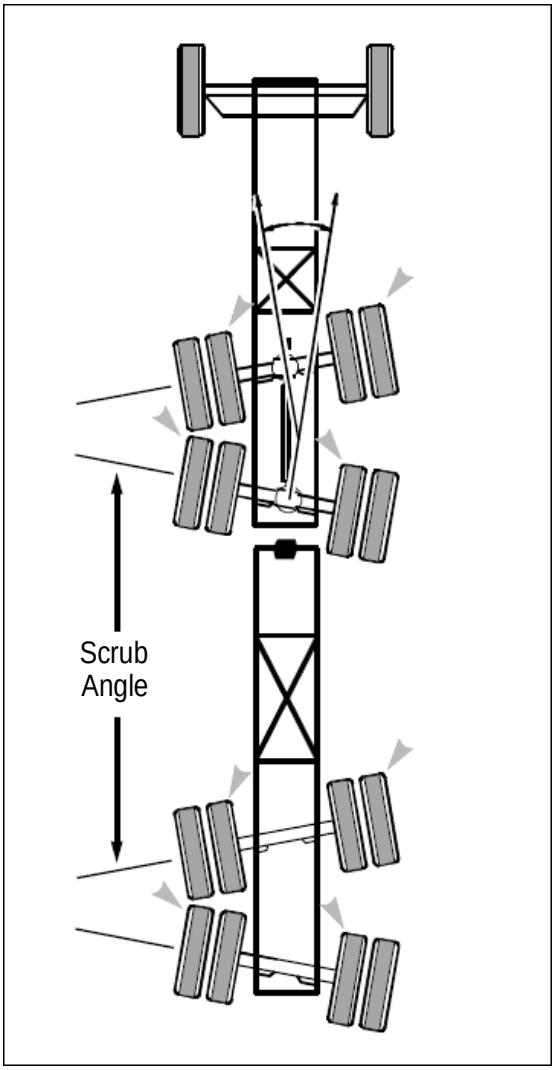
The steer axle must be turned to offset the "push of the axles and keep the vehicle moving straigh ahead. This causes every tire on the vehicle to



Tire wear from tandem scrub occuts at tLe leading edge of the steer tires, in a pattern callec "inside/outside" wear. For example, on the front axle of this vehicle, wear would occur on the outside of the left steer tire and on the inside of the right steer tire. Tire wear would occur on all drive axle tires.

Trailer Alignment and Tire Wear

TLesameconltons LWca e andem a ub 0P!tJC!0tSJlS0JQQl}!0!tJC!0t-!tJlEt combnaions



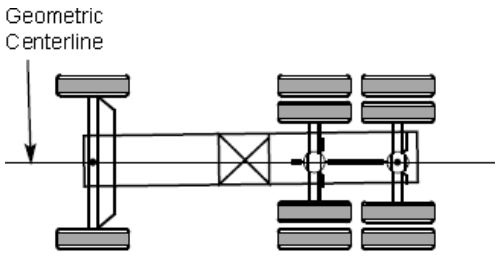
resulting in rapid wear on all tires.

If the trailer doesn't track correctly, it exposes more area to wind resistance. This can affect handling and fuel economy.

Alignment Angles Effect Rolling Resistance and Fuel E0/fSUf P‹"^^*

While the effects of misalignment show clearly in tire wear, the effects on fuel consumption are less easy to quantify. Fuel consumption is affected by many factors.

OWPVP,i!iS0 Vi0US!6!IiS6ijNIPN!Il!%I rfP3SP 0l0j B fiJ0CB—60/ 0l0j B fiJ ISJIJ{0fCJUSB0 UBlC00SUI@!IOO



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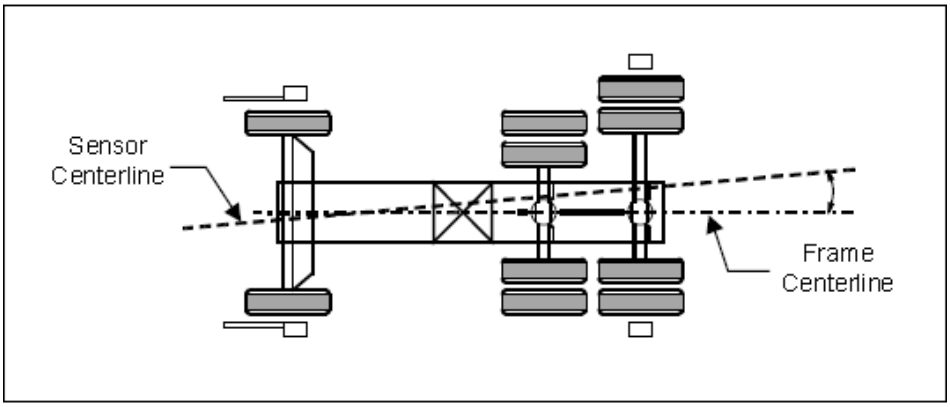
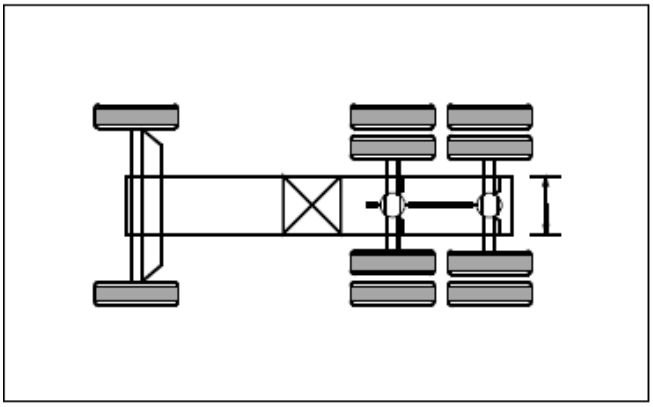
The alignment system will establish the Geometric Centerline.

Frame Centerline Alignment



Frame offset angle is the angle of the frame referenced to the sensor centerline. This angle is calculated by the aligner when requested measurements are entered into the aligner.

Separation



Separation is the distance between the reference axle adjustment points. This distance may be measured and entered into the aligner before adjusting thrust angle to allow the aligner to calculate how much the axle must be moved at the adjustment point.

6. Suspension System Fundamentals

PURPOSE OF THE SUSPENSION SYSTEM

As we review suspension system components and how they work together, remember that a vehicle in motion is more than wheels turning. As the tire revolves, the suspension system is in a dynamic state of balance, continuously compensating and

adjusting for changing driving conditions. Today's suspension system is automotive engineering at its best.

The components of the suspension system perform six basic functions:

1. Maintain correct vehicle ride height
2. Reduce the effect of shock forces
3. Maintain correct wheel alignment
4. Support vehicle weight
5. Keep the tires in contact with the road
6. Control the vehicle's direction of travel

However, in order for this to happen, all the suspension components, both front and rear, must be in good working condition.

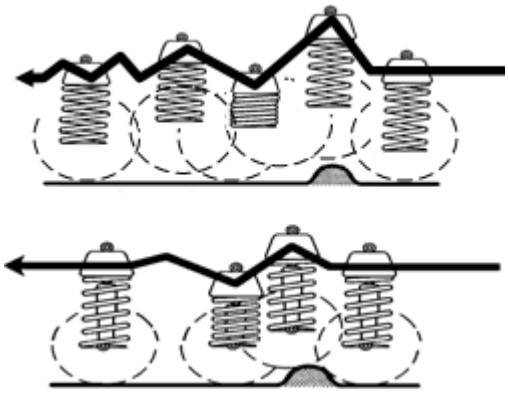
MAIN COMPONENTS OF A MODERN SUSPENSION SYSTEM

At this point, it's important to understand that the main components of a moving vehicle suspension system are the *Struts, Shock Absorbers, Springs and Tires*. We will first turn our attention to the design and function of springs. In the following section we will thoroughly examine the function and design of shock absorbers and strut assemblies.

The springs support the weight of the vehicle, maintain ride height, and absorb road shock. Springs are the flexible links that allow the frame and the body to ride relatively undisturbed while the tires and suspension follow the bumps in the road.

Springs are the compressible link between the frame and the body. When an additional load is placed on the springs or the vehicle meets a bump in the road, the springs will absorb the load by compressing. The springs are a very important component of the suspension system that provides ride comfort. Shocks and struts help control how fast the springs and suspension are allowed to move, which is important in keeping tires in firm contact with the road.

During the study of springs, the term bounce refers to the vertical (up and down) movement of the suspension system. The upward suspension travel that compresses the spring and shock absorber is called the jounce, or compression. The downward travel of the tire and wheel that extends the spring and shock absorber is called rebound, or extension.



When the spring is deflected, it stores energy. Without shocks and struts the spring will extend and release this energy at an uncontrolled rate. The spring's inertia causes it to bounce and overextend itself. Then it re-compresses, but will again travel too far. The spring continues to bounce at its natural frequency until all of the energy originally put into the spring is used.

If the struts or shock absorbers are worn and the vehicle meets a bump in the road, the vehicle will bounce at the frequency of the suspension until the energy of the bump is used up. This may allow the tires to lose contact with the road.

Struts and shock absorbers that are in good condition will allow the suspension to oscillate through one or two diminishing cycles, limiting or damping excessive movement, and maintaining vertical loads placed upon the tires. This helps keep the tires in contact with the road.

By controlling spring and suspension movement, components such as tie rods will operate within their design range and, while the vehicle is in motion, dynamic wheel alignment will be maintained.

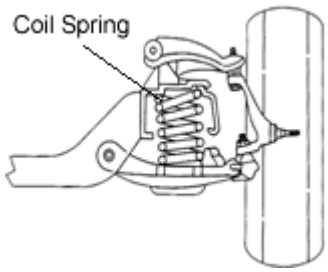
SPRING DESIGNS

Before discussing spring design, it is important to understand sprung and unsprung weight. Sprung weight is the weight supported by the springs. For example, the vehicle's body, transmission, frame, and motor would be sprung weight. Unsprung weight is the weight that is not carried by springs, such as the tires, wheels, and brake assemblies.

The springs allow the frame and vehicle to ride undisturbed while the suspension and tires follow the road surface. Reducing unsprung weight will provide less road shock. A high sprung weight along with a low unsprung weight provides improved ride and also improved tire traction.

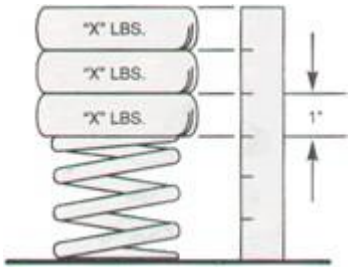
There are four major spring designs in use today: coil, leaf, torsion bar, and air.

Coil Springs



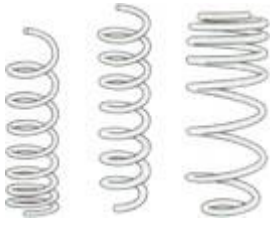
The most commonly used spring is the coil spring. The coil spring is a length of round spring steel rod that is wound into a coil. Unlike leaf springs, conventional coil springs do not develop inter-leaf friction. Therefore, they provide a smoother ride.

The diameter and length of the wire determine the strength of a spring. Increasing the wire diameter will produce a stronger spring, while increasing its length will make it more flexible.



Spring rate, sometimes referred to as deflection rate, is used to measure spring strength. It is the amount of weight that is required to compress the spring 1 inch. For example: If it takes 100 lbs. to compress a spring 1inch, it would take to 200 lbs. to compress the spring 2 inches.

Some coil springs are made with a variable rate. This variable rate is accomplished by either constructing this spring from materials having different thickness or by winding the spring so the coil will progressively compress at a higher rate. Variable rate springs provide a lower spring rate under unloaded conditions offering a smoother ride, and a higher spring rate under loaded conditions, resulting in more support and control.



Coil springs require no adjustment and for the most part are trouble-free. The most common failure is spring sag. Springs that have sagged below vehicle design height will change the alignment geometry. This can create tire wear, handling

problems, and wear other suspension components. During suspension service it is very important that vehicle ride height be measured. Ride height measurements not within manufacturer's specifications require replacement of springs.

Leaf Springs

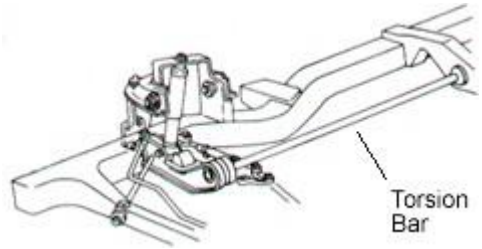
Leaf springs are designed two ways: multi-leaf and mono-leaf. The multi-leaf spring is made of several steel plates of different lengths stacked together. During normal operation, the spring compresses to absorb road shock. The leaf springs bend and slide on each other allowing suspension movement.

An example of a mono-leaf spring is the tapered leaf spring. The leaf is thick in the middle and tapers toward the two ends. Many of these leaf springs are made of a composite material, while others are made of steel.

In most cases leaf springs are used in pairs mounted longitudinally (front to back). However, there are an increasing number of vehicle manufacturers using a single transverse (side to side) mounted leaf spring.

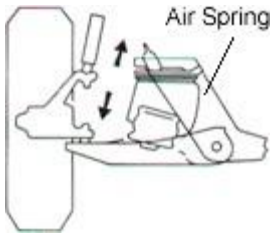
Torsion Bar

Another type of spring is the torsion bar. The torsion bar is a straight or L shaped bar of spring steel. Most torsion bars are longitudinal, mounted solidly to the frame at one end and connected to a moving part of the suspension at the other. Torsion bars may also be transverse mounted. During suspension movement, the torsion bar will twist, providing spring action.



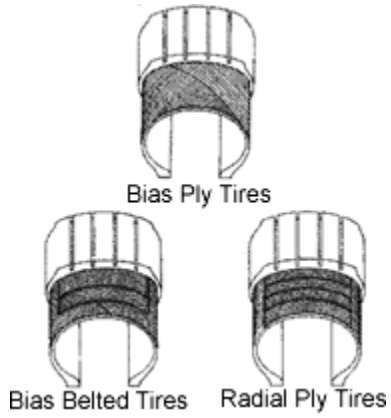
Air Springs

The air spring is another type of spring that is becoming more popular on passenger cars, light trucks, and heavy trucks. The air spring is a rubber cylinder filled with compressed air. A piston attached to the lower control arm moves up and down with the lower control arm. This causes the compressed air to provide spring action. If the vehicle load changes, a valve at the top of the airbag opens to add or release air from the air spring. An onboard compressor supplies air.



Tires as Springs

An often-overlooked spring is the tire. Tires are air springs that support the total weight of the vehicle. The air spring action of the tire is very important to the ride quality and safe handling of the vehicle. As a matter of fact, tires may be viewed as the number-one ride control component. Tire size, construction, compound and inflation are very important to the ride quality of the vehicle.

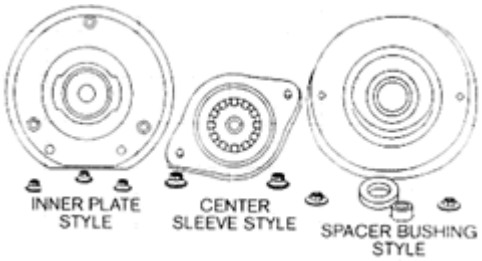


There are three basic types of tires: radial ply, bias ply, and bias belted.

Radial ply tires have ply cords, which run across the centerline of the tread and around the tire. The two sets of belts are at right angles. Some belts are made of steel wire; others are made of polyester or other substances. Today, radial tires come as original equipment on most passenger cars and light trucks.

Bias ply tires use cords that run at an angle across the centerline of the tire tread. The alternate ply cords cross at opposite angles. Bias belted tires are the same as bias ply, with the addition of layers of cords - or belts - circling the tire beneath the tread. Both of these types of tires will most likely be found on older model vehicles.

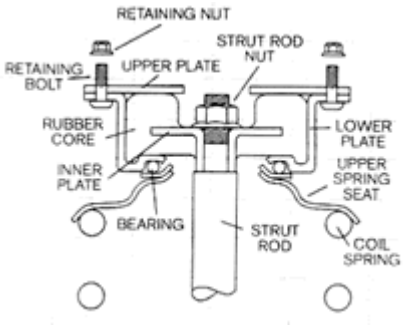
The air pressure determines the spring rate of the tire. An over inflated tire will have a higher spring rate and will produce excessive road shock. Over inflated tires will transmit road shock rather than reduce it. Over or under inflation also affects handling and tire wear.



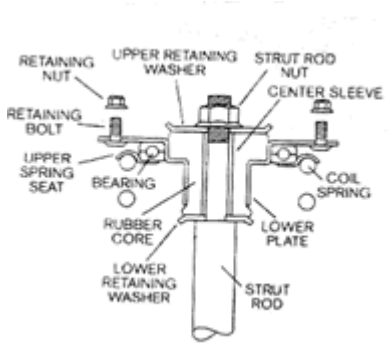
When adjusting tire pressure, always refer to the vehicle manufacturer's specifications, not the specification on the side of the tire. The air pressure specified by the vehicle manufacturer will provide safe operation and best overall ride quality of the vehicle. The tire pressure stamped on the side is the maximum pressure a tire is designed to hold at a specific load.

STRUT MOUNT DESIGN

Strut mounts are vehicle specific, and there are numerous designs in use today on both front and rear suspension systems. The three most common designs are inner plate, center sleeve, and spacer bushing.

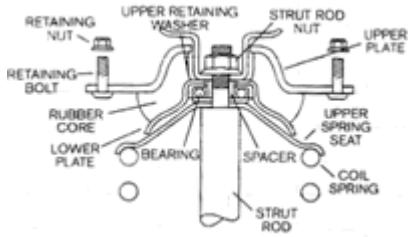


The ***Inner Plate Design*** used by General Motors and some Ford applications feature an inner plate encased in molded rubber surrounded by upper and lower surface plates. The inner plate is designed so the strut piston rod cannot push through the upper or lower surface plate if the rubber core fails. This design generally does not require washers. Due to the fact that the upper and lower service plates mostly cover the rubber portion of the mount, it is difficult to see if the inner rubber bushing has failed. However, these components wear over time and with a thorough inspection a proper recommendation can be made. The bearing is located on the bottom of the strut mount and is not serviceable. Defective bearing will require replacement of the entire strut mount.



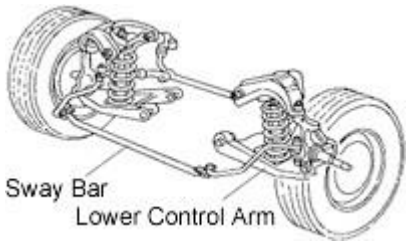
The ***Center Sleeve Design*** used by Chrysler features a center sleeve that is molded to the rubber bushing. This design provides increased side to side stability. The strut stem extends through the center sleeve. Upper and lower retainer washers prevent the strut rod from pushing through the strut mount. The bearing is a separate component from the strut mount. If inspection reveals cracks or tears in the rubber bushing, replacement is required. If the bearing is found to be defective it can be replaced separately.

The ***Spacer Bushing Design*** used by Volkswagen, Toyota, Mazda, Mitsubishi, and early Chrysler vehicles feature center positioning of the bearing and a separate inner bushing instead of a molded inner sleeve. The operation is similar to the style we just discussed except the bearing is pressed in the strut mount. The bearings, washer, and the upper plate retain the strut rod. If the rubber bushing is cracked, torn, or the bearing is binding or seized, the strut mount requires replacement.



ANTI-SWAY BARS

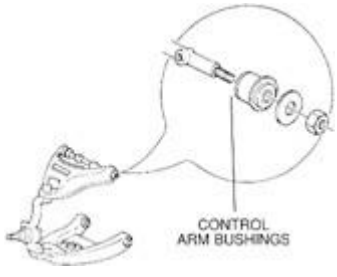
Another important component of a suspension system is the anti-sway bar. This device is used along with shock absorbers to provide additional stability. The anti-sway bar is simply a metal rod connected to both of the lower control arms. When the suspension at one wheel moves up and down the anti-sway bar transfers the movement to the other wheel. In this way the sway bar creates a more level ride and reduces vehicle sway or lean during cornering.



Depending of the anti-sway bar thickness and design, it can provide as much as 15% reduction in the amount of vehicle roll or sway during cornering.

BUSHINGS

Bushings are used in many locations on the vehicle suspension system. Most bushings are made with natural rubber. However, in some cases, urethane compounds may be used. Bushings made of natural



rubber offer high tensile (tear) strength and excellent stability at low temperatures. Natural rubber is an elastomeric material. Elastomeric refers to the natural elastic nature of rubber to allow movement of the bushing in a twisting plane. Movement is controlled by the design of the rubber element. Natural rubber requires no lubrication, isolates minor vibration, reduces transmitted road shock, operates noise free, and offers a large degree of bushing compliance. Bushing compliance permits movement without binding. Natural rubber resists permanent deflections, is water resistant and very durable. In addition, natural rubber offers high load carrying capabilities.

As with all suspension system components, control arm bushings are dynamic components, meaning that they operate while the vehicle is in motion. Control arms act as locators because they hold the position of the suspension in relation to the chassis. They are attached to the vehicle frame with rubber elastomeric bushings. During suspension travel, the control arm bushings provide a pivot point for the control arm. They also maintain the lateral and vertical location of the control arm pivot points, maintain dynamic wheel alignment, and reduce transmitted noise, road shock, and vibration, while providing resistance to suspension movement.

During suspension travel the rubber portion of the bushing must twist to allow control arm movement. Control arm bushings that are in good condition act as a spring; that is, the rubber will spring back to the position from which it started. This twisting action of the rubber will provide resistance to suspension movement.

As previously stated, control arm bushings are dynamic suspension components. As the control arm travels through jounce and rebound, the rubber portion of the bushing will twist and stretch. This action transfers energy into the bushing and generates heat.

Excessive heat tends to harden the rubber. As the rubber bushing hardens, it tends to crack, break, and then disintegrate. Its temperature determines the life of a rubber bushing. Rough road conditions and/or defective shock absorbers or struts will allow excessive suspension movement creating more heat, which shortens the life of the bushings.

Rubber bushings must not be lubricated with petroleum-based oil. A petroleum-based product will destroy the bushings. Instead, use a special tire rubber lubricant or a silicone based lubricant.

Worn suspension bushings allow the control arm to change positions. This results in driveline vibration (primarily rear wheel drive rear control arm bushings), dynamic alignment angle changes, tire wear, and handling problems. Control arm bushing wear (looseness) will create a clunking sound while driving over rough roads.

7. The valve

A valve consists of an externally threaded hollow cylindrical metal tube, typically of brass. In the center of the exterior end is a metal pin pointing along the axis of the tube; the pin's end is approximately flush with the end of the valve body.

Generally, all valves used on tires have threads and bodies of a single standard size at the exterior end, so caps and tools generally are universal for the valves on all common applications.

The valve cap is important on a valve because if one is not fitted, dirt and water can enter the outside of the valve, potentially jamming it or contaminating the sealing surfaces and causing a leak. Salt and other chemical if used near the tires are especially damaging for the brass components in the valve.