

Steering and Suspension

Suspension Systems

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Steering and Suspension

Suspension System Purpose

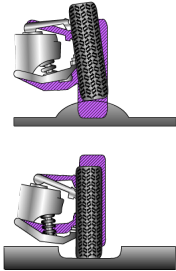
- The suspension system and frame must provide:
 - steering control under all road conditions
 - maintain proper vehicle tracking and directional stability
 - a comfortable ride
 - proper wheel alignment and minimize tire wear



Steering and Suspension

Jounce and Rebound

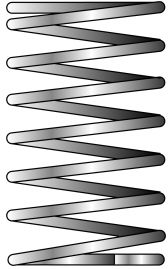
- Jounce is the upward movement or compression of suspension components
- Rebound is the downward movement or extension of suspension components



Steering and Suspension

Sprung and Un-Sprung Weight

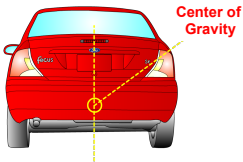
- Un-sprung weight
 - Wheels and tires
 - Wheel bearings and hubs
 - Axles and steering knuckles
 - Wheel mounted brake components
- Sprung weight
 - Body and frame
 - Engine and transmission
 - Load or cargo
 - Fuel tank



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Center of Gravity

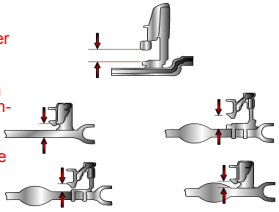
- The point around which the vehicle's weight is centered
- As weight distribution is altered, the CG is moved
- Excessive sprung weight loaded higher than the CG will seriously reduce the handling characteristics of a vehicle



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Ride Height

- Ride height is the height at which a vehicle's sprung components are carried over the vehicle's un-sprung components
- Ride height is a suspension measurement taken from un-sprung to sprung components
- Vehicle ride height is not the same as:
 - Vehicle trim height
 - Curb riding height
 - Side-to-side lean



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Vehicle Trim Height

- Side-to-side lean is a term used to describe the difference in the height of the vehicle body usually measured from a point on the body to the ground on both sides of the vehicle

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Setback

- Setback is a reference to the difference in side-to-side wheelbase
- Positive Setback
 - The RH wheelbase is longer, using the left side as a base
- Negative Setback
 - The RH wheelbase is shorter, using the left side as a base

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Thrust Angle

- Angle between the vehicle's centerline and the thrust-line of the rear axle
 - Negative - rear wheels point left

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Thrust Angle

- Angle between the vehicle's centerline and the thrust-line of the rear axle
 - Negative - rear wheels point left
 - Positive - rear wheels point right

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Caster Angle

- Forward or rearward inclination of the steering axis
- Directional control angle
 - vehicle will pull to the least positive side
- Not a tire wear angle

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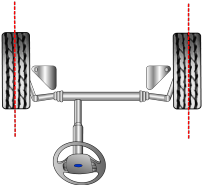
Camber Angle

- Inward or outward tilt of the wheel and tire when viewed from the front of the vehicle
- Directional control angle
 - vehicle will pull to the most positive side
- Tire wear angle

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Toe Angle

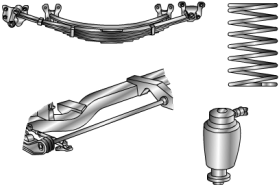
- Inward or outward variation of tires from a straight ahead position
- Toe In vs. Toe Out
- Not a directional control angle
- Tire wear angle



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Springs

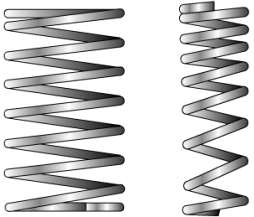
- Springs support the vehicle's weight located above the springs
- Coil springs
- Leaf springs
- Torsion bars
- Air springs



Steering and Suspension

Coil Springs Types


- Uniformly spaced coils provide a linear compression rate
- Variable rate springs provide a comfortable ride with increased loading capacities
- Variable rate coil springs are normally installed with the tight coils up as shown here



Steering and Suspension

Shock Absorbers

- Control spring oscillation and rebound
- Reduce body sway and lean on turns
- Reduce the tendency of a tire to lift off the road



Steering and Suspension

Shock Absorber Operation

- Shock absorbers and struts are used to control vehicle jounce and rebound
- Shock absorbers are double acting
 - Ratios are expressed as extension/compression
 - Ratios from 50/50 to 80/20 are available
 - A ratio of 70/30 is common



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Shock Absorber Inspection

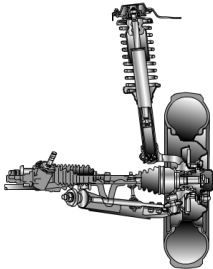
- Visual inspection
 - Oil film verses leakage
- Bounce test
 - Push the bumper down with considerable force. One upward free bounce should stop the vehicle motion
- Manual test
 - A shock absorber should offer steady resistance for the entire rebound and compression stroke



Steering and Suspension

MacPherson Struts

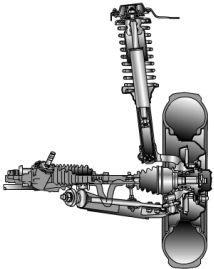
- The strut mounts to the knuckle/spindle at one end and to the chassis or body at the other end
- On front suspension systems the upper end of the strut assembly rotates in the strut bearings



Steering and Suspension

MacPherson Strut Service

- Strut bearing noise
- Noise due to coil spring insulator damage or misalignment
- Noise due to coil spring interference with the upper rebound stop, strut tower or strut mount assembly
- Some strut cartridges are replaced on car, but most require the strut and spring assembly be removed from the vehicle for service



Steering and Suspension

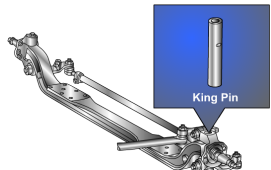
Strut Service Precautions

- Always use a coil spring compressing tool according to the tool or vehicle manufacturer's recommended service procedure.
- Be sure the tool is properly installed on the spring.
- Never loosen the upper strut mount retaining nut on the end of the strut rod unless all spring tension is removed from the upper strut mount.
- Never clamp the strut or shock absorber in a vice with excessive force.
- If the coil spring has an enamel-type or plastic coating and the compressing tool damages the finish it may lead to premature spring failure.

Steering and Suspension

King Pins

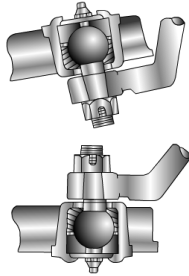
- King pins may be used as steering pivot points on vehicles with solid front axles or twin I-beam suspension systems
- Large steel or fiber pins fit into eyes in the steering knuckle and into a hole in each end of the axle



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Ball Joints

- Ball joints are the pivot points that allow the spindles or steering knuckles to turn
- Load carrying
- Non-load carrying



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Ball Joint Service

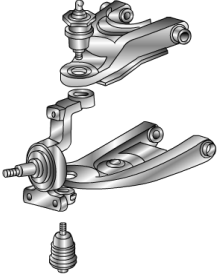
- Ball joint failures
 - Noise
 - Excessive steering effort
 - Poor steering return ability
- Ball joints inspection
 - Wear indicators
 - Travel
 - Articulation effort
- Ball joints are often serviced as a control arm assembly



Steering and Suspension

Control Arms

- Control arms allow the suspension to move up and down in response to irregularities in the road surface
- They are attached to the chassis with bushings and to the knuckle/spindle with ball joints or bushings



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Bushings

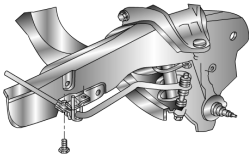
- Bushings are used to provide a firm yet flexible mounting point for suspension components
- Bushings should be inspected for deterioration and/or damage



Steering and Suspension

Stabilizer Bars

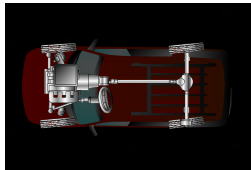
- The stabilizer bar helps to control body roll on turns
- The stabilizer bar is attached to the suspension members on each side of the vehicle and to the chassis with bushings
- The spring steel bar resists twisting and forces the vehicle to shift its weight back into the turn, instead of away from it



Steering and Suspension

Suspension Inspection

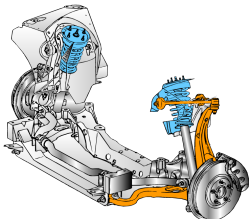
- Spring condition
- Shock absorbers
- Control arms
- Sway bars
- Links, arms, etc.
- Bushings
- Ride height



Steering and Suspension

Front Suspension Types

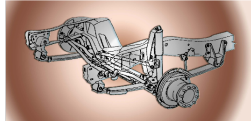
- Solid Front axle
- Twin I-beam
- Short over long arm
- Torsion bar
- MacPherson strut
- Modified MacPherson strut



Steering and Suspension

Solid Front Axle

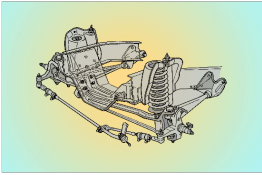
- Solid front axles deliver a high load capacity at the expense of driving comfort and performance
- The axles may be driven or non-driven and commonly use leaf style springs



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Twin I-Beam

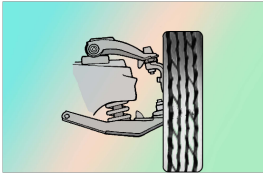
- I-beams are mounted to pivot points on the opposite side of the vehicle
- Coil springs support the vehicle's weight between the I-beam and the frame
- Radius arms control lateral and torsional movement of the I-beams
- Provides good load capacity and vehicle ride characteristics



Steering and Suspension

Short Over Long Arm

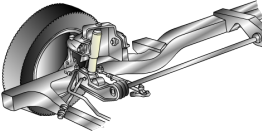
- Two control arms are attached to the frame
- During jounce and rebound the two length control arms move the tire through an arc maintaining the tire to road alignment
- Reduced tire wear, improved ride quality and directional control



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Torsion Bar

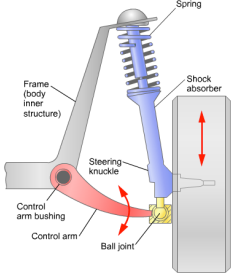
- Torsion bars are spring steel bars mounted to the control arm and the frame of the vehicle
- The torsion bar is the only spring that is manually adjustable to correct ride height
- Torsion bars are marked right and left, and must be installed on the correct side of the vehicle



Steering and Suspension

MacPherson Strut

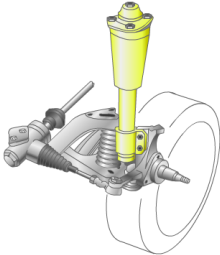
- The spring and shock are combined to form the strut assembly
- The steering knuckle and strut pivot at the lower ball-joint and the upper strut bearing
- Compact design



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Modified MacPherson Strut

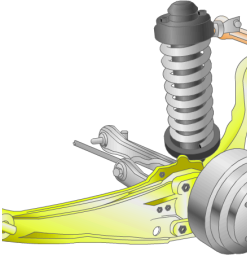
- The coil spring is located between the control arm and frame
- The shock attaches to the steering knuckle and pivots at the lower ball joint and upper strut bearing



Steering and Suspension

Rear Suspension Types

- Rigid rear axle
 - Leaf spring
 - Coil spring
 - Strut
- Semi-Independent
 - Twist beam axle
- Independent
 - MacPherson strut
 - Short over long arm



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Leaf Spring

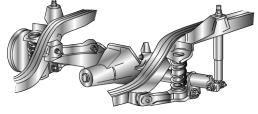
- Leaf springs can support large amounts of sprung vehicle weight
- Leaf springs also provide excellent fore, aft and lateral control of the axle
- Materials other than steel have been used leaf spring production



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Coil Spring

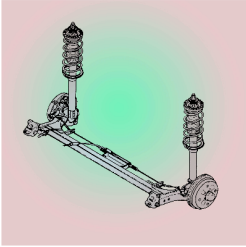
- Coil springs require links, bars, struts or arms to control fore, aft and lateral movement of the axle
- Commonly used in RWD cars where compact design and ride quality are more important than load capacity



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Semi-Independent

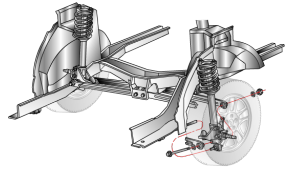
- A twist beam-type axle is used to reduce jounce and rebound transfer to the other wheel as the vehicle encounters road imperfections
- MacPherson struts are often used to support the vehicle's weight, but an upper strut pivot bearing is not required



Steering and Suspension

Independent Rear Strut

- Each rear wheel can move independently from the opposite rear wheel
- Ride quality, tire life, steering control and traction are improved
- Independent rear suspension is used on FWD and RWD vehicles



Steering and Suspension

Independent Rear SLA

- Rear SLA systems include an upper and lower control arm, a spring, and a shock absorber
- The spindles are held in place with links, bars or arms since the tires are not normally used for steering

