2B

WHEEL ALIGNMENT

SPECIFICATIONS

Wheel Alignment Specifications

Application	Front	Rear
Camber	-20´ ± 45´	-1° ± 45´
Caster	4° ± 45´	-
Toe-in (No person, full tank)	0° ± 10´	12´ ± 10´

Fastener Tightening Specifications

Application	N•m	Lb-Ft	Lb-In
Rear Parallel Link-to-Crossmember Nut	90	66	-

DIAGNOSIS

Tire Diagnosis

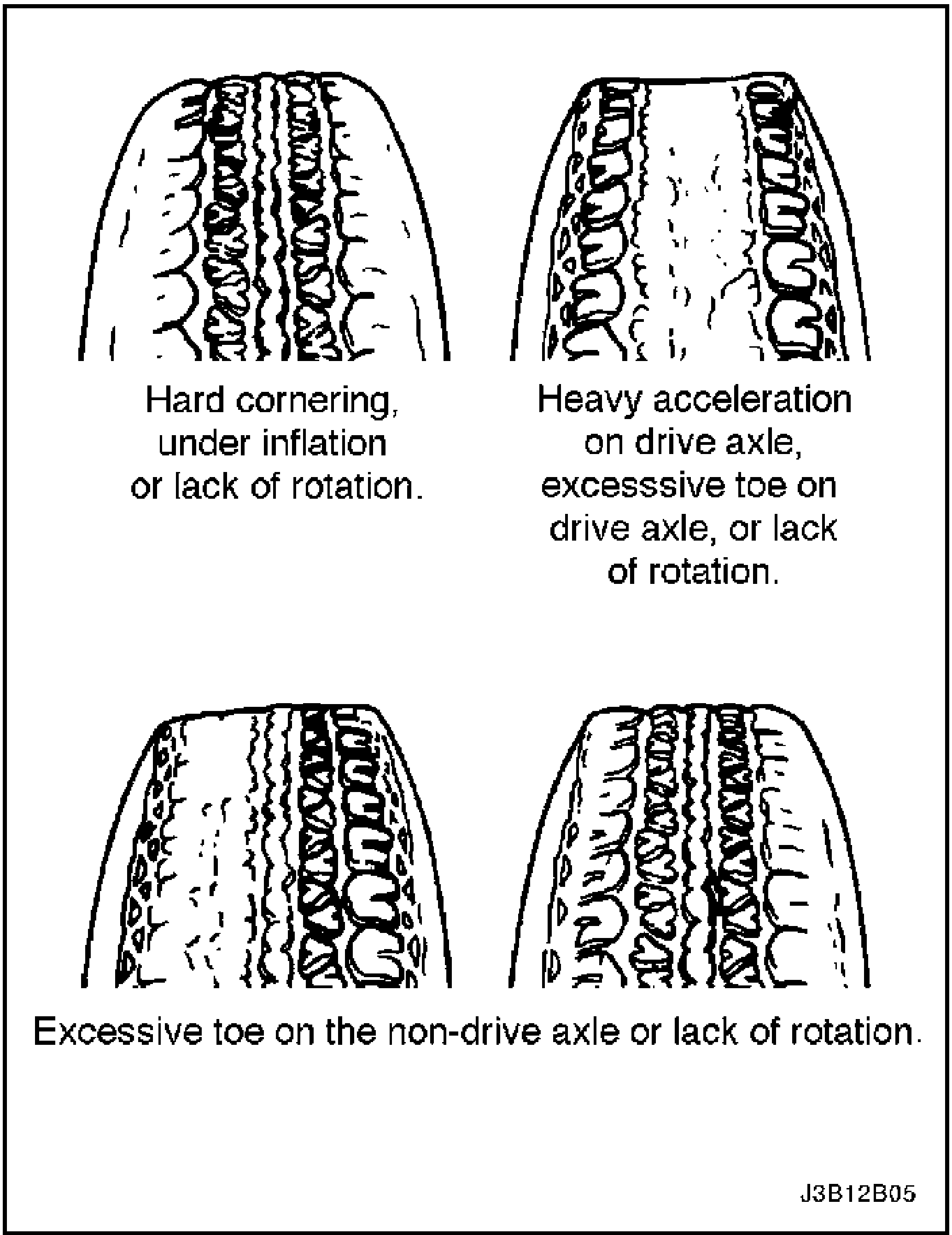
Irregular and Premature Wear

Irregular and premature tire wear has many causes. Some of them are incorrect inflation pressures, lack of regular rotation, poor driving habits, or improper wheel alignment. If the wheel alignment is reset because of tire wear, always reset the toe as close to zero degrees as the specification allows. Refer to "Rear Toe Adjustment" in this section.
Rotate the tires if:

- The front tire wear is different from the rear.
- The left and right front tire wear is unequal.
- The left and right rear tire wear is unequal.

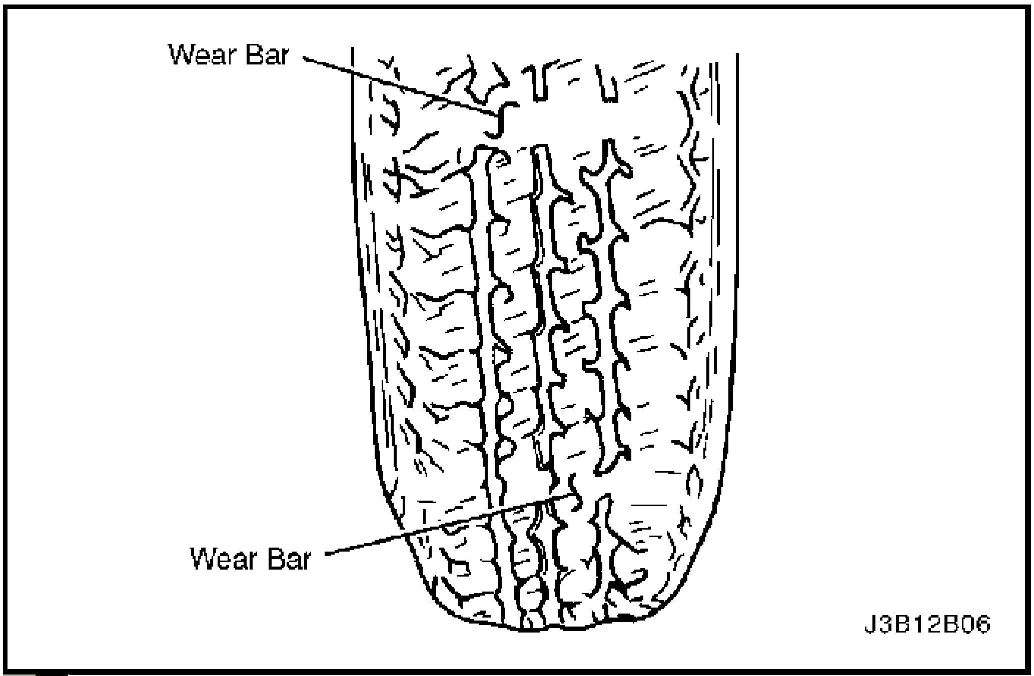
Check wheel alignment if:

- The left and right front tire wear is unequal.
- The wear is uneven across the tread of either front tire.
- The front tire treads are scuffed with "feather" edges on the side of the tread ribs or blocks.



Tread Wear Indicators

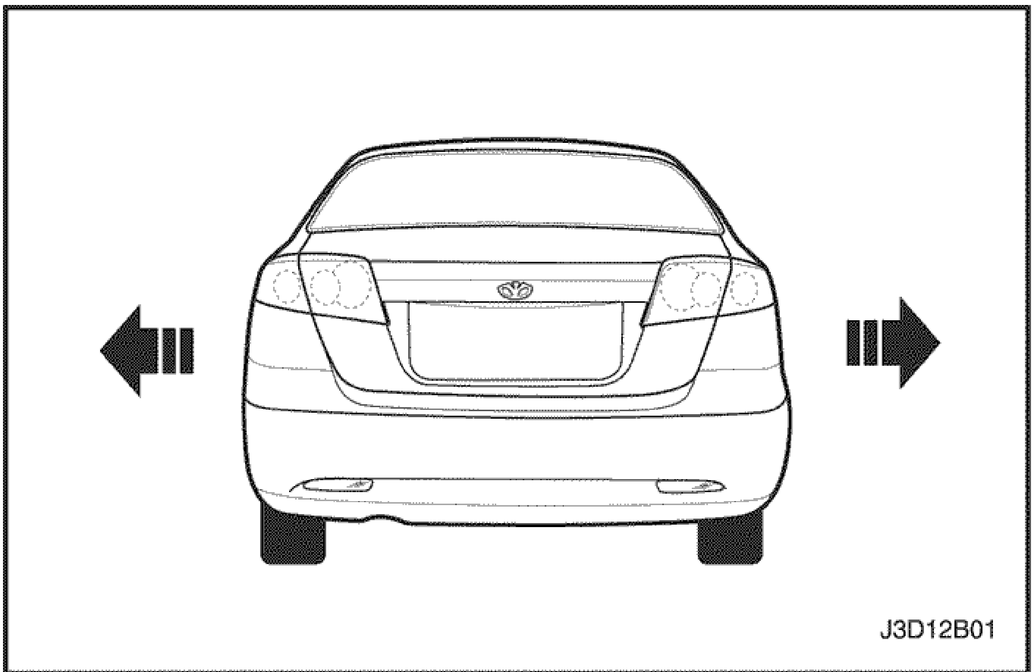
The original equipment tires have built-in tread wear indicators to show when the tires need replacement. These indicators appear as bands when the tire tread depth becomes shallow. Tire replacement is recommended when the indicators appear in three or more grooves at six locations.



Radial Tire Waddle

Waddle is side-to-side movement at the front or rear of the vehicle. It is caused by the steel belt not being straight within the tire, or by excessive lateral runout of the tire or wheel. It is most noticeable at low speeds, 8 to 48 km/h (5 to 30 mph), but may appear as ride roughness at 80 to 113 km/h (50 to 70 mph).
The vehicle must be road tested to determine which end of the vehicle has the faulty tire. The rear end of the vehicle will shake from side to side or "waddle" if the waddle tire is on the rear of the vehicle. From the driver's seat, it feels as though someone is pushing on the side of the vehicle. If the faulty tire is on the front of the vehicle, the waddle is more visual. The front sheet metal appears to be moving back and forth, and the driver's seat feels like the pivot point in the vehicle.
Waddle can be diagnosed using the method of substi-tuting known good tire and wheel assemblies on the problem vehicle.

1. Road test the vehicle to determine if the waddle is coming from the front or the rear of the vehicle.
2. Install good tires and wheels from a similar vehicle in place of those on the offending end of the problem vehicle. If the source of the waddle is not obvious, change the rear tires.
3. Road test the vehicle. If there is improvement, install the original tires to find the offending tire. If there is no improvement, install good tires in place of all four offending tires.
4. Install original tires one at a time to find the offending tire.



Radial Tire Lead/Pull

Lead/pull is the deviation of the vehicle from a straight path on a level road with no pressure on the steering wheel. Lead is usually caused by:

- Incorrect alignment.
- Uneven brake adjustment.
- Tire construction.

The way in which a tire is built can produce lead/pull in the vehicle. Off-center belts on radial tires can cause the tire to develop a side force while the vehicle rolls straight down the road. If one side of the tire has even a little larger diameter than the diameter of the other side, the tire will tend to roll to one side. Unequal diameters will cause the tire to develop a side force which can produce vehicle lead/pull.
The radial lead/pull diagnosis chart should be used to determine whether the problem originates from an alignment problem or from the tires. Part of the lead diagnosis procedure calls for tire rotation that is different from the proper tire rotation pattern. If a medium- to high-mileage tire is moved to the other side of the vehicle, be sure to check for ride roughness. Rear tires will not cause lead/pull.

Radial Tire Lead/Pull Diagnosis Chart

1	1. Perform wheel alignment preliminary inspection. 2. Check the brakes for dragging. 3. Road test the vehicle. Does the vehicle lead/pull?	-	Go to *Step 2*	System OK
2	1. Cross switch the front tire and wheel assemblies. 2. Road test the vehicle. Does the vehicle lead/pull?	-	Go to *Step 3*	System OK
3	Check the front wheel alignment. Is the alignment within specifications?	-	Go to *Step 4*	Adjust alignment
4	Compare the front camber and front caster to specifications. Are they within specifications?	-	Go to *Step 7*	Go to *Step 5*
5	Check the vehicle frame. Is the frame bent?	-	Go to *Step 6*	Go to *Step 1*
6	Straighten the frame. Is the repair complete?	-	Go to *Step 3*	-
7	1. The probable cause is the tires. 2. Switch the left front tire and wheel assembly with the left rear tire and wheel assembly. 3. Road test the vehicle. Does the vehicle still lead/pull?	-	Go to *Step 9*	Go to *Step 8*
8	Switch the left front tire and wheel assembly with the left rear tire and wheel assembly and replace the left front tire. Is the repair complete?	-	System OK	Go to *Step 1*
9	1. Switch the right front tire and wheel assembly with the right rear tire and wheel assembly. 2. Road test the vehicle. Does the vehicle still lead/pull?	-	Go to *Step 1*	Go to *Step 10*
10	Switch the right front tire and wheel assembly with the right rear tire and wheel assembly and replace the right front tire. Is the repair complete?	-	System OK	Go to *Step 1*

Vibration Diagnosis

Wheel imbalance causes most highway speed vibration problems. A vibration can remain after dynamic balancing because:

- A tire is out of round.
- A rim is out of round.
- A tire stiffness variation exists.

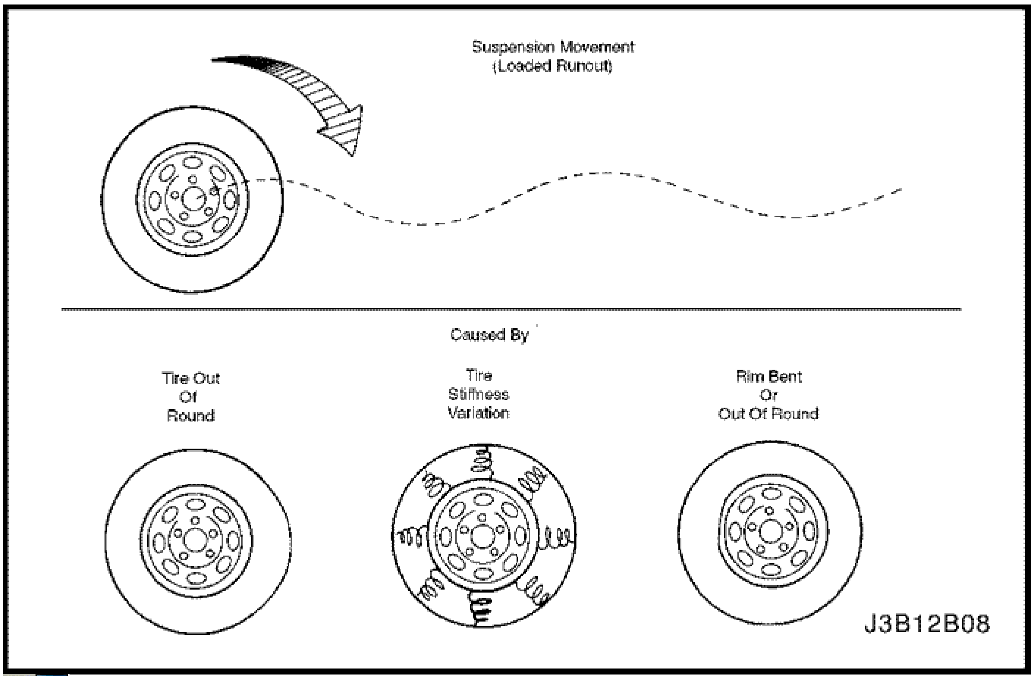
Measuring tire and wheel free runout will uncover only part of the problem. All three causes, known as loaded radial runout, must be checked using method of substituting known good tire and wheel assemblies on the problem vehicle.
Low-speed vibrations, which occur below 64 km/h (40 mph), are usually caused by runout. High-speed vibrations, which occur above 64 km/h (40 mph), can be caused by either imbalance or runout.

Preliminary Checks

Prior to performing any work, always road test the car and perform a careful visual inspection for:

- Obvious tire and wheel runout.

- Obvious drive axle runout.
- Improper tire inflation.
- Incorrect trim height.
- Bent or damaged wheels.
- Debris build-up on the tire or the wheel.
- Irregular or excessive tire wear.
- Improper tire bead seating on the rim.
- Imperfections in the tires, including: tread deformations, separations, or bulges from impact damage. Slight sidewall indentations are normal and will not affect ride quality.



Tire Balancing

Balance is the easiest procedure to perform and should be done first if the vibration occurs at high speeds. Do an off-vehicle, two-plane dynamic balance first to correct any imbalance in the tire and wheel assembly.
An on-vehicle finish balance will correct any brake drum, rotor, or wheel cover imbalance. If balancing does not correct the high-speed vibration, or if the vibration occurs at low speeds, runout is the probable cause.

Runout

Runout can be caused by the tire, the wheel, or the way the wheel is attached to the vehicle. To investigate the possibility of wheel runout, refer to the following procedures as well as the wheel runout diagnosis chart in this section:

1. If runout is suspected, measure the on-vehicle free lateral and free radial runout of the tire and wheel assembly. Refer to *Section 2E, Tires and Wheels.*Both the free lateral and the free radial runout should be less than 1.5 mm (0.06 inch). If either measurement exceeds this number, proceed to Step 2.
2. Mount the tire and the wheel on a dynamic balancing machine and remeasure the free lateral and the free radial runout. Record the amount of the free lateral and the free radial runout and the location of the highest measurement. Refer to *Section 2E, Tires and Wheels.*If the free radial or the free lateral runout exceeds 1.3 mm (0.05 inch) at the tire tread, proceed to Step 4.
3. Measure the wheel runout. Refer to *Section 2E, Tires and Wheels.*If the wheel exceeds specifications, replace it.
4. Deflate the tire and match-mount the high radial runout point of the tire to the low radial runout point of the wheel. Reinflate the tire and mount it on the dynamic balancing machine. Measure and record the free radial and the free lateral runout and their locations. In many cases, match mounting the tire on the wheel will bring the tire and wheel assembly's free runout into an acceptable range of 1.3 mm (0.05 inch) or less.
5. If the free runout of the tire and wheel assembly is 1.3 mm (0.05 inch) or less when it was measured off the vehicle, yet exceeds 1.3 mm (0.05 inch) when measured on the vehicle, the attachment of the tire and wheel assembly to the hub is the probable cause of the vibration. Rotate the assembly's two wheel studs and recheck the runout. Refer to *Section 2E, Tires and Wheels.*Several positions may have to be tried to find the best location for the studs.
6. If the tire and wheel assembly free runout cannot be reduced to 1.3 mm (0.05 inch) or less, remove the assembly.
    1. Measure the wheel stud runout using a dial indicator set with a magnetic base.
    2. Zero the dial indicator set button on one stud.
    3. Gently lift the set button off the stud. Rotate the flange to position the next stud against the dial indicator set.
    4. Record the runout of all the studs. The dial indicator should read zero when it is repositioned on the first stud that was checked.
    5. If the runout exceeds 0.76 mm (0.03 inch), the hub or the hub and bearing assembly should be replaced.

Whenever a tire is rotated on the wheel, or whenever a tire or wheel is replaced, rebalance the assembly.

Wheel Runout Diagnosis Chart

1	Road test the vehicle to verify the vibration complaint. Are the customer's concerns verified?	-	Go to *Step 2*	System OK
2	1. Perform a vibration diagnosis preliminary check. 2. Repair any of the problems found. Is the vibration still present?	-	Go to *Step 3*	System OK
3	Determine at what speed the vibration is present. Is the vibration over 64 km/h (40 mph)?	-	Go to *Step 4*	Go to *Step 6*
4	Perform off-vehicle dynamic wheel balance. Is the vibration still present?	-	Go to *Step 5*	System OK
5	Perform on-vehicle finish balance. Is the vibration still present?	-	Go to *Step 6*	System OK
6	Perform free lateral and radial on-vehicle runout check. Does the runout match the value specified?	1.5mm (0.06 in.)	Go to *Step 4*	Go to *Step 7*
7	Perform free lateral and free radial off-vehicle runout check. Does the runout match the value specified?	1.3mm (0.05 in.)	Go to *Step 8*	Go to *Step 12*
8	1. Index the tire and wheel assembly on the wheel studs. 2. Obtain the least amount of runout possible. Does the runout match the value specified?	0.76mm (0.03 in.)	Go to *Step 9*	Go to *Step 14*
9	Perform off-vehicle dynamic wheel balance. Is the vibration still present?	-	Go to *Step 10*	System OK
10	Perform on-vehicle finish balance. Is the vibration still present?	-	Go to *Step 11*	System OK
11	1. Check for any engine driveline imbalance. 2. Thoroughly inspect the drive axles and the constant velocity joints. 3. Repair any problems found. Are the repairs complete?	-	Go to *Step 1*	-
12	1. Match-mount the tire on the wheel. 2. Perform free lateral and free radial off-vehicle runout check. Does the runout match the value specified?	1.5mm (0.06 in.)	Go to *Step 9*	Go to *Step 13*
13	1. Dismount the tire from the wheel of the suspected assembly. 2. Measure the runout of the wheel. Does the runout match the value specified?	0.8mm (0.03 in.)	Go to *Step 15*	Go to *Step 16*
14	Measure the hub flange runout. Does the runout match the value specified?	0.76mm (0.03 in.)	Go to *Step 9*	Go to *Step 17*
15	Replace the tire. Is the repair complete?	-	Go to *Step 1*	-
16	Replace the wheel. Is the repair complete?	-	Go to *Step 1*	-
17	Replace the hub. Is the repair complete?	-	Go to *Step 1*	-

Preliminary Inspection

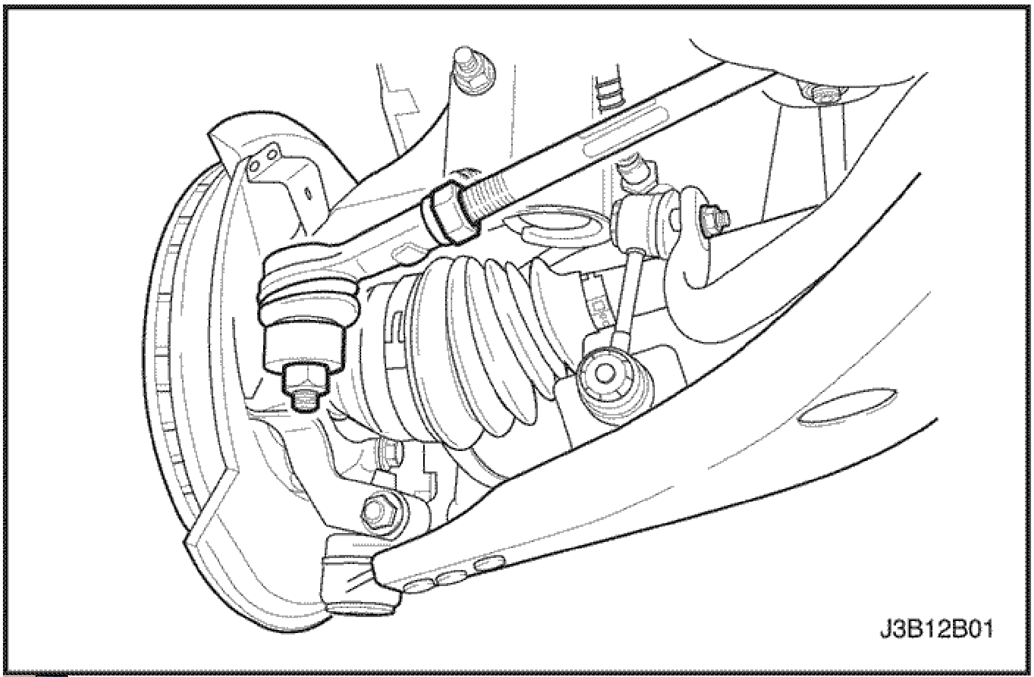
Checks	Action
Check the tires for proper inflation pressures and normal tread wear.	Inflate the tires to the proper tire pressure. Replace the tires as needed.
Check the wheel bearings for looseness.	Tighten the axle nut to the proper specification. Replace the strut wheel bearing as needed.
Check for loose ball joints and tie rod ends.	Tighten the ball joints and the tie rods.
Check the runout of the wheels and the tires.	Measure and correct the tire runout.
Check the vehicle trim heights.	Correct the trim heights. Make the correction before adjusting the toe.
Check for loose rack and pinion mounting.	Tighten the mounting brackets for the rack and pinion assembly.
Check for improperly operating struts.	Replace the strut assembly.
Check for loose control arms.	Tighten the control arm attachment bolts. Replace the control arm bushings as needed.

Front Toe Adjustment

1. Disconnect the outer tie rods from the knuckle assemblies. Refer to *Section 6C, Power Steering Gear.*
2. Turn the right and the left outer tie rods and the adjuster nuts to align the toe to 0.0 ± 0.10 degree.

3. Reconnect the outer tie rods to the knuckle assemblies. Refer to *Section 6C, Power Steering Gear.*

In this adjustment, the right and the left tie rods must be equal in length, or the tires will wear unevenly.



Front Camber and Caster Check

The front camber and caster are not adjustable. Refer to "Wheel Alignment Specifications" in this section. Jounce the bumper three times before measuring the camber or the caster in order to prevent an incorrect reading. If the front camber or caster measurements deviate from the specifications, locate and replace or repair any damaged, loose, bent, dented, or worn suspension part. If the problem is body related, repair the body.

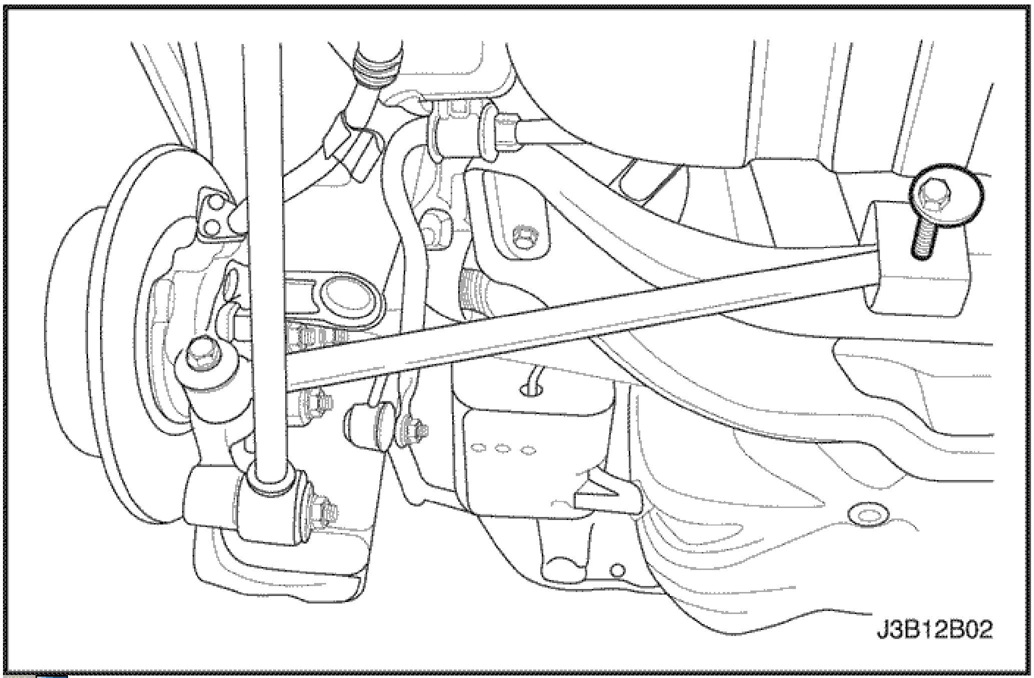
Rear Camber Check

The rear camber is not adjustable. Refer to "Wheel Alignment Specifications" in this section. If the rear camber deviates from the specification, locate the cause and correct it. If damaged, loose, bent, dented, or worn suspension parts are found, they should be repaired or replaced. If the problem is body related, repair the body.

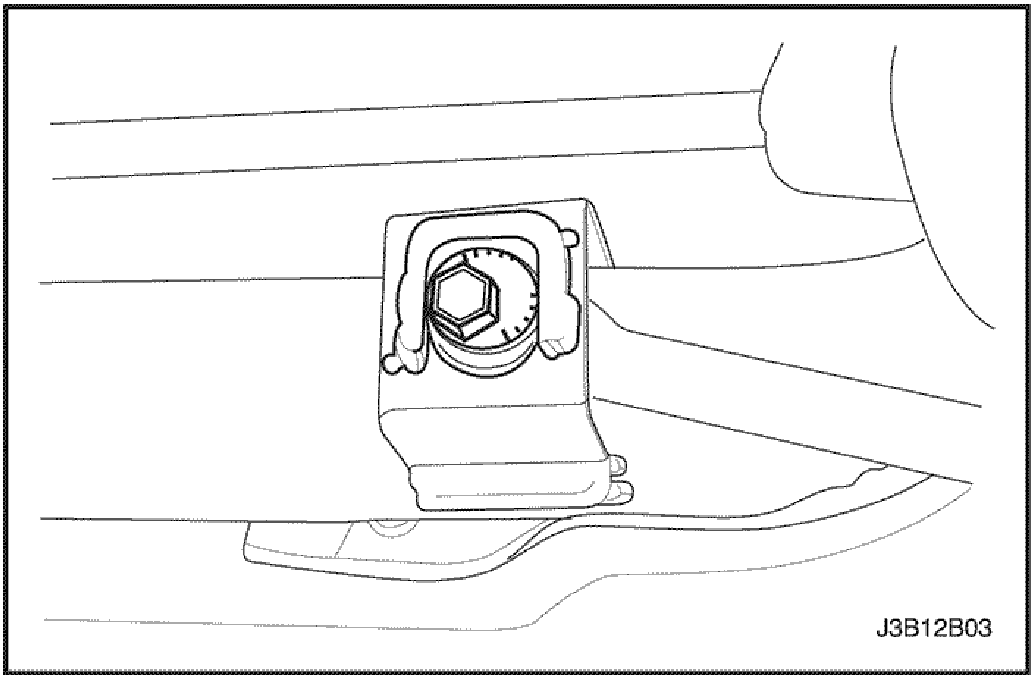
Rear Toe Adjustment

Adjustment Procedure

1. Perform a preliminary inspection before any attempt is made to change or correct the wheel alignment factors. Refer to "Preliminary Inspection" in this section.
2. Loosen the nuts on the parallel link-to-crossmember bolts.

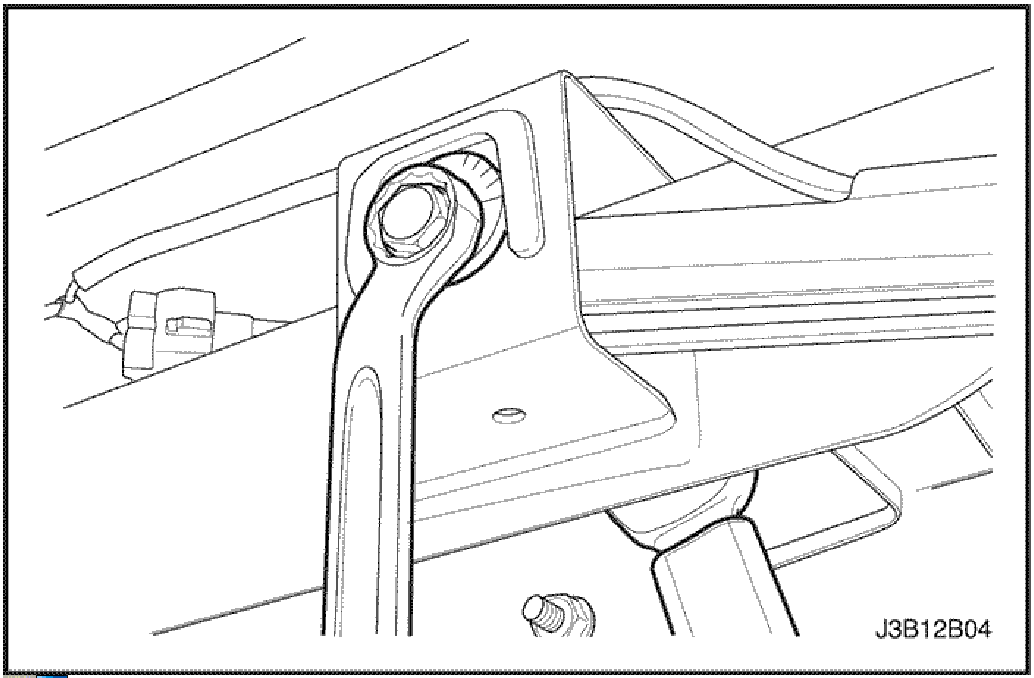


3. Rotate the parallel link adjustment bolts until the preferred rear toe specification is obtained. Refer to "Wheel Alignment Specifications" in this section for preferred specifications.



4. Hold the parallel link adjustment bolts and tighten the parallel link-to-crossmember nuts.

Tighten the parallel link-to-crossmember nuts to 90 N•m (66 lb-ft).



GENERAL DESCRIPTION AND SYSTEM OPERATION

Four Wheel Alignment

The first responsibility of engineering is to design safe steering and suspension systems. Each component must be strong enough to withstand and absorb extreme punishment. Both the steering system and the front and the rear suspension must function geometrically with the body mass.
The steering and the suspension systems require that the front wheels self-return and that the tire rolling effort and the road friction be held to a negligible force in order to allow the customer to direct the vehicle with the least effort and the most comfort.
A complete wheel alignment check should include measurements of the rear toe and camber.
Four-wheel alignment assures that all four wheels will be running in precisely the same direction.
When the vehicle is geometrically aligned, fuel economy and tire life are at their peak, and steering and performance are maximized.

Toe

Toe-in is the turning in of the tires, while toe-out is the turning out of the tires from the geometric centerline or thrust line. The toe ensures parallel rolling of the wheels.
The toe serves to offset the small deflections of the wheel support system which occur when the vehicle is rolling forward. The specified toe angle is the setting which achieves 0 degrees of toe when the vehicle is moving.
Incorrect toe-in or toe-out will cause tire wear and reduced fuel economy. As the individual steering and suspension components wear from vehicle mileage, additional toe will be needed to compensate for the wear.
Always correct the toe dimension last.

Caster

Caster is the tilting of the uppermost point of the steering axis either forward or backward from the vertical when viewed from the side of the vehicle. A backward tilt is positive, and a forward tilt is negative. Caster influences directional control of the steering but does not affect tire wear. Weak springs or overloading a vehicle will affect caster. One wheel with more positive caster will pull toward the center of the car. This condition will cause the car to move or lean toward the side with the least amount of positive caster. Caster is measured in degrees and is not adjustable.

Camber

Camber is the tilting of the top of the tire from the vertical when viewed from the front of the vehicle. When the tires tilt outward, the camber is positive. When the tires tilt inward, the camber is negative. The camber angle is measured in degrees from the vertical. Camber influences both directional control and tire wear.
If the vehicle has too much positive camber, the outside shoulder of the tire will wear. If the vehicle has too much negative camber, the inside shoulder of the tire will wear.
Camber is not adjustable.

Steering Axis Inclination

Steering Axis Inclination (SAI) is the tilt at the top of the steering knuckle from the vertical. Measure the SAI angle from the true vertical to a line through the center of the strut and the lower ball joint as viewed from the front of the vehicle.
SAI helps the vehicle track straight down the road and assists the wheel back into the straight ahead position. SAI on front wheel drive vehicles should be negative.

Included Angle

The included angle is the angle measured from the camber angle to the line through the center of the strut and the lower ball joint as viewed from the front of the vehicle.
The included angle is calculated in degrees. Most alignment racks will not measure the included angle directly. To determine the included angle, subtract the negative or add the positive camber readings to the Steering Axis Inclination (SAI).

Scrub Radius

The scrub radius is the distance between true vertical and the line through the center of the strut and lower ball joint to the road surface. Scrub radius is built into the design of the vehicle. Scrub radius is not adjustable.

Setback

The setback is the distance in which one front hub and bearing assembly may be rearward of the other front hub and bearing assembly. Setback is primarily caused by a road hazard or vehicle collision.

Turning Angle

The turning angle is the angle of each front wheel to the vertical when the vehicle is making a turn.