SPECIFICATIONS

WHEEL ALIGNMENT SPECIFICATIONS

Wheel Alignment Specifications

Suspension	Camber	Camber Cross Tolerance	Caster	Caster Cross Tolerance	Total Toe	Steering Wheel Angle	Thrust Angle
Front	-0.60° +/- 0.75°	0.00° (+) 0.75°	LH 3.15° (+) 0.75° RH 2.90° (+) 0.75°	0.25° (+) 0.75°	0.15° (+) 0.15°	-0.0 (+) 3.50°	-
Rear	-0.5° (+) 0.75°	0.00° (+) 0.75°	-	-	-0.2° (+) 0.20°	-	0.0° (+) 0.20°
Red Line							
Front	-0.90° (+) 0.75°	(+) 0.75°	LH 3.35° (+) 0.75° RH 3.10° (+) 0.75°	0.25°+/- 0.75°	+0.15° (+) 0.15°	-0.00° (+) 3.50°	-
Rear	-0.50° (+) 0.75°	(+) 0.75°	-	-	+0.20° (+) 0.20°	-	0.00° (+) 0.20°

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Rear Upper Control Arm to Frame Bolt	110 N.m	81 lb ft
Strut to Knuckle Nut and Bolt	180 N.m	133 lb ft
Tie Rod Jam Nut	60 N.m	44 lb ft
Toe Link To Frame Fastener Bolt	110 N.m	81 lb ft

REPAIR INSTRUCTIONS

MEASURING WHEEL ALIGNMENT

Steering and vibration complaints are not always the result of improper alignment. One possible cause is wheel and tire imbalance. Another possibility is tire lead due to worn or improperly manufactured tires. Lead/pull is defined as follows: At a constant highway speed on a typical straight road, lead/pull is the amount of effort required at the steering wheel to maintain the vehicle's straight path. Lead is the vehicle deviation from a straight path on a level road without pressure on the steering wheel. Refer to **Radial Tire Lead/Pull**

Correction in Tires and Wheels in order to determine if the vehicle has a tire lead problem.

Before performing any adjustment affecting wheel alignment, perform the following inspections and adjustments in order to ensure correct alignment readings:

- Inspect the tires for the proper inflation and irregular tire wear. Refer to **Tire Inflation Pressure Specifications** in Maintenance and Lubrication and **Tire Diagnosis - Irregular or Premature Wear** in Tires and Wheels.
- Inspect the runout of the wheels and the tires. Refer to **Tire and Wheel Runout Specifications** in Vibration Diagnosis and Correction.
- Inspect the wheel bearings for backlash and excessive play. Refer to **Wheel Bearings Diagnosis** in Suspension General Diagnosis.
- Inspect the ball joints and tie rod ends for looseness or wear.
- Inspect the control arms and stabilizer shaft for looseness or wear.
- Inspect the steering gear for looseness at the frame. Refer to **Fastener Tightening Specifications** in Power Steering System.
- Inspect the struts/shock absorbers for wear, leaks, and any noticeable noises. Refer to **Struts or Shock Absorbers On-Vehicle Testing** in Suspension General Diagnosis.
- Inspect the vehicle trim height. Refer to **Trim Height Inspection Procedure** in Suspension General Diagnosis.
- Inspect the steering wheel for excessive drag or poor return due to stiff or rusted linkage or suspension components.
- Inspect the fuel level. The fuel tank should be full or the vehicle should have a compensating load added.

Give consideration to excess loads, such as tool boxes, sample cases, etc. If normally carried in the vehicle, these items should remain in the vehicle during alignment adjustments. Give consideration also to the condition of the equipment being used for the alignment. Follow the equipment manufacturer's instructions.

Satisfactory vehicle operation may occur over a wide range of alignment settings. However, if the setting exceeds the service allowable specifications, correct the alignment to the service preferred specifications. Refer to **Wheel Alignment Specifications** .

Perform the following steps in order to measure the front and rear alignment angles:

1. Install the alignment equipment according to the manufacturer's instructions.
2. Jounce the front and the rear bumpers 3 times prior to checking the wheel alignment.
3. Measure the alignment angles and record the readings.

IMPORTANT: When performing adjustments to vehicles requiring a 4-wheel alignment, set the rear wheel alignment angles first in order to obtain proper front alignment angles.

4. Adjust alignment angles to vehicle specification, if necessary. Refer to **Wheel Alignment Specifications** .

FRONT CASTER ADJUSTMENT

The front caster is not adjustable. If the front caster angle is not within specifications, inspect for suspension support misalignment or front suspension damage. Refer to **Alignment Checking** in Frame and Underbody. Replace any damaged suspension components as necessary.

FRONT CAMBER ADJUSTMENT

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** in General Information.
2. Remove the wheel and tire assemblies. Refer to **Tire and Wheel Removal and Installation** in Tires and Wheels.

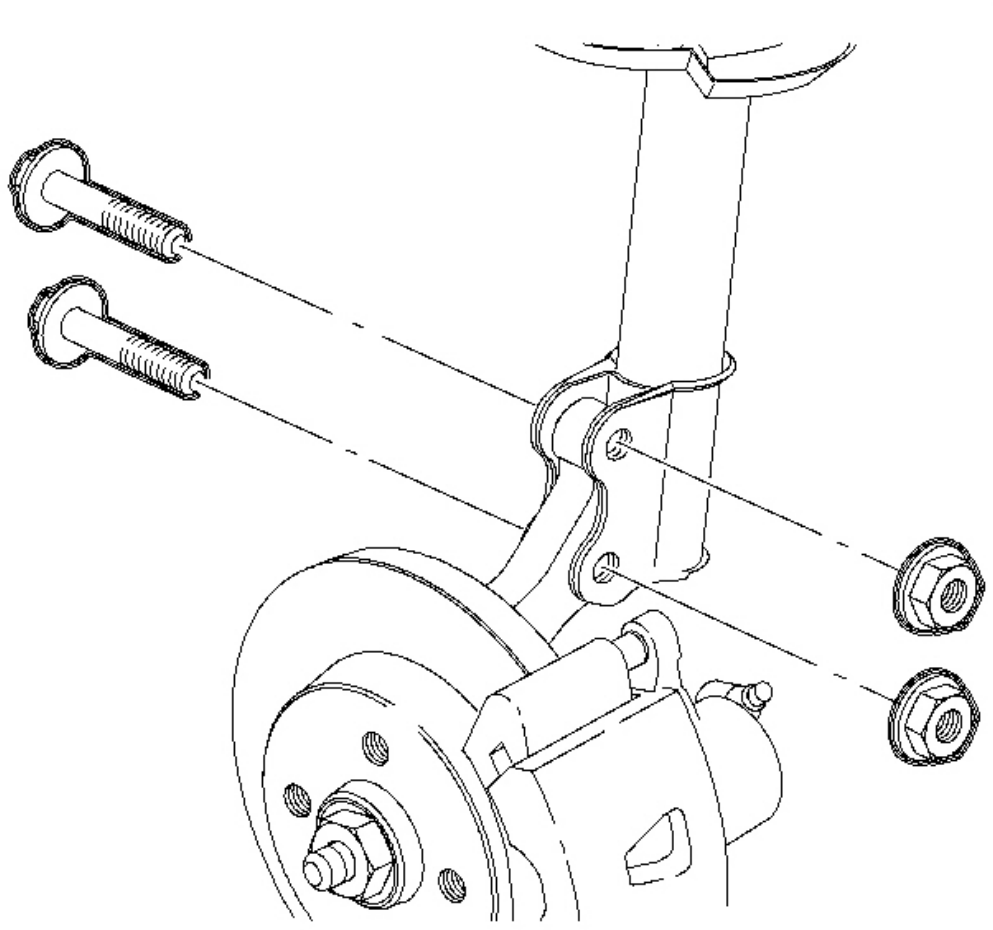

Fig. 1: Strut, Knuckle Nuts & Bolts

Courtesy of GENERAL MOTORS CORP.

3. Remove the strut to knuckle nuts and bolts. Discard the nuts and bolts.

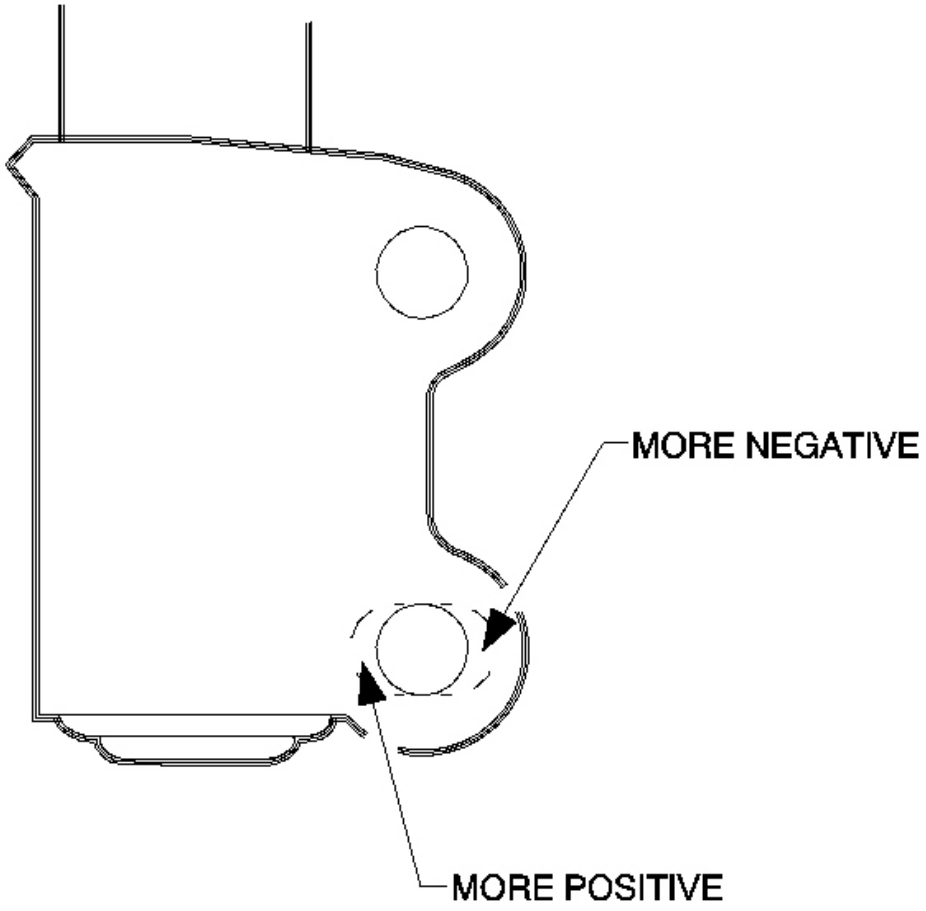

Fig. 2: Strut & Knuckle
Courtesy of GENERAL MOTORS CORP.

4. If the strut has not been previously modified, perform the following procedure:
    1. Disconnect the strut from the knuckle.

IMPORTANT:

- **The strut mounting bracket consists of two layers of metal, file the inner layer no further than the slot in the outer layer.**

- **If filing the strut, paint the exposed metal with primer.**

2. If increasing negative camber, remove material from the outside of the lower strut hole.
3. If decreasing negative camber, remove material from the inside of the lower strut hole.

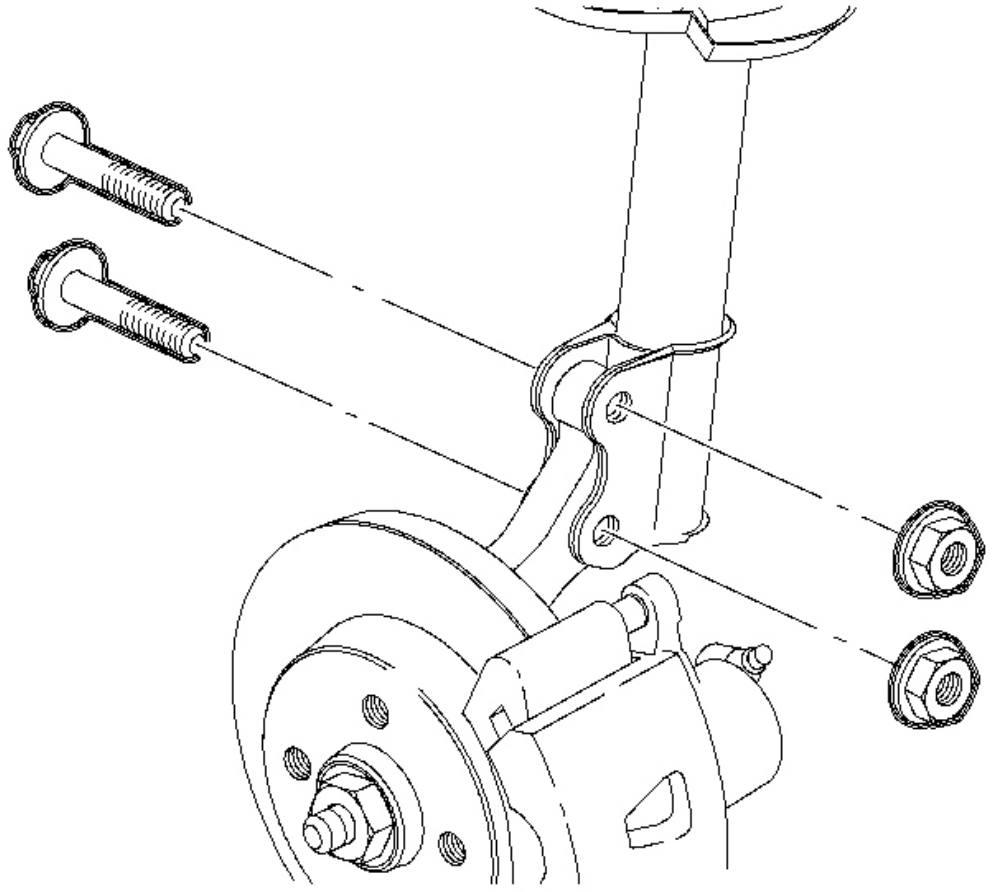

Fig. 3: Strut, Knuckle Nuts & Bolts
Courtesy of GENERAL MOTORS CORP.

5. Loosely install new strut to knuckle nuts and bolts.

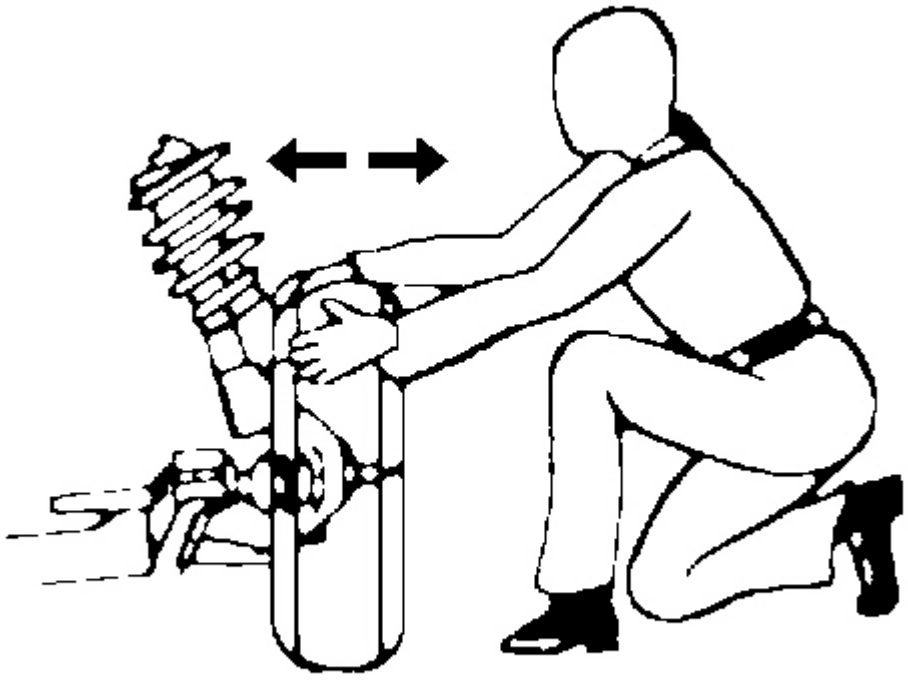

Fig. 4: Adjusting The Camber Specifications By Moving The Top Of Wheel In Or Out
Courtesy of GENERAL MOTORS CORP.

6. Adjust the camber to specifications by moving the top of the wheel in or out as necessary. Refer to **Wheel Alignment Specifications** .

   NOTE: Refer to Fastener Notice in Cautions and Notices.

7. Tighten strut to knuckle nuts and bolts.

   Tighten: Tighten the nuts and bolts to 180 N.m (133 lb ft).

8. Install the wheel and tire assemblies. Refer to **Tire and Wheel Removal and Installation** in Tires and Wheels.

FRONT TOE ADJUSTMENT

1. Position and lock the steering wheel with the vehicle with the wheels in the straight forward position.

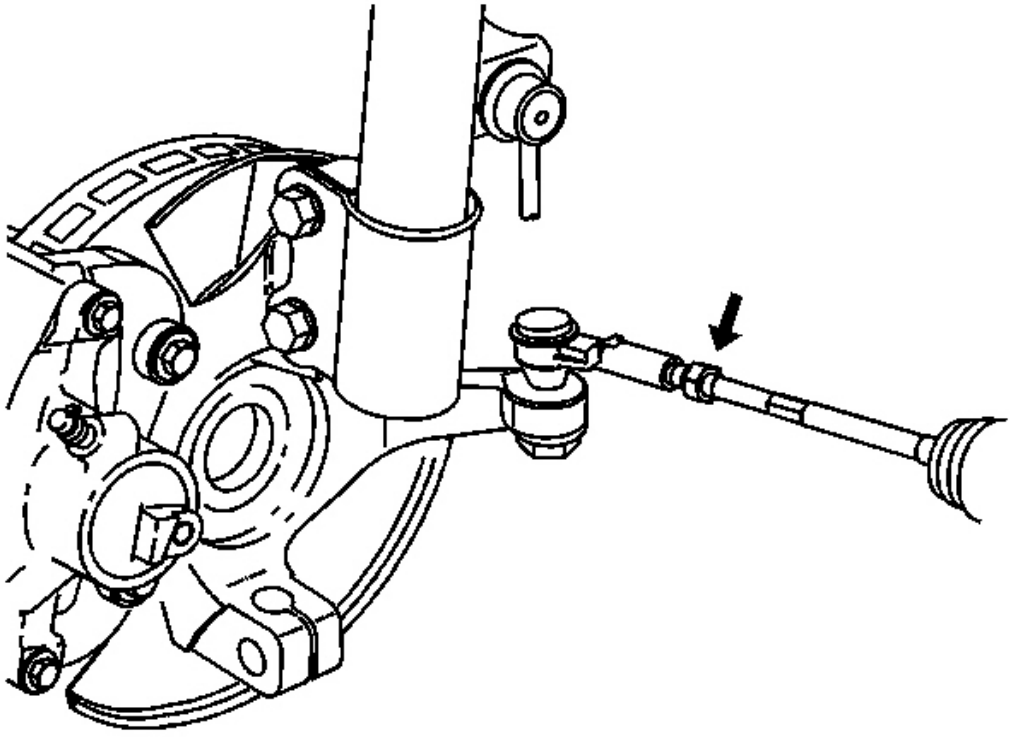

Fig. 5: Inner Tie Rod Jam Nuts
Courtesy of GENERAL MOTORS CORP.

2. Loosen both inner tie rod jam nuts.

IMPORTANT: The inner tie rod must rotate freely from the boot seal surface. Do not allow the boot to rotate.

3. Loosen the inner tie rod seal to boot surface.
4. Use a wrench on the tie rod flats to increase or decrease the toe angle specifications. Refer to **Wheel Alignment Specifications** .

NOTE: Refer to Fastener Notice in Cautions and Notices.

5. Tighten the inner tie rod jam nuts.

Tighten: Tighten the jam nuts to 60 N.m (44 lb ft).

6. Inspect the toe angle to ensure proper adjustment and adjust as necessary.

REAR CAMBER ADJUSTMENT

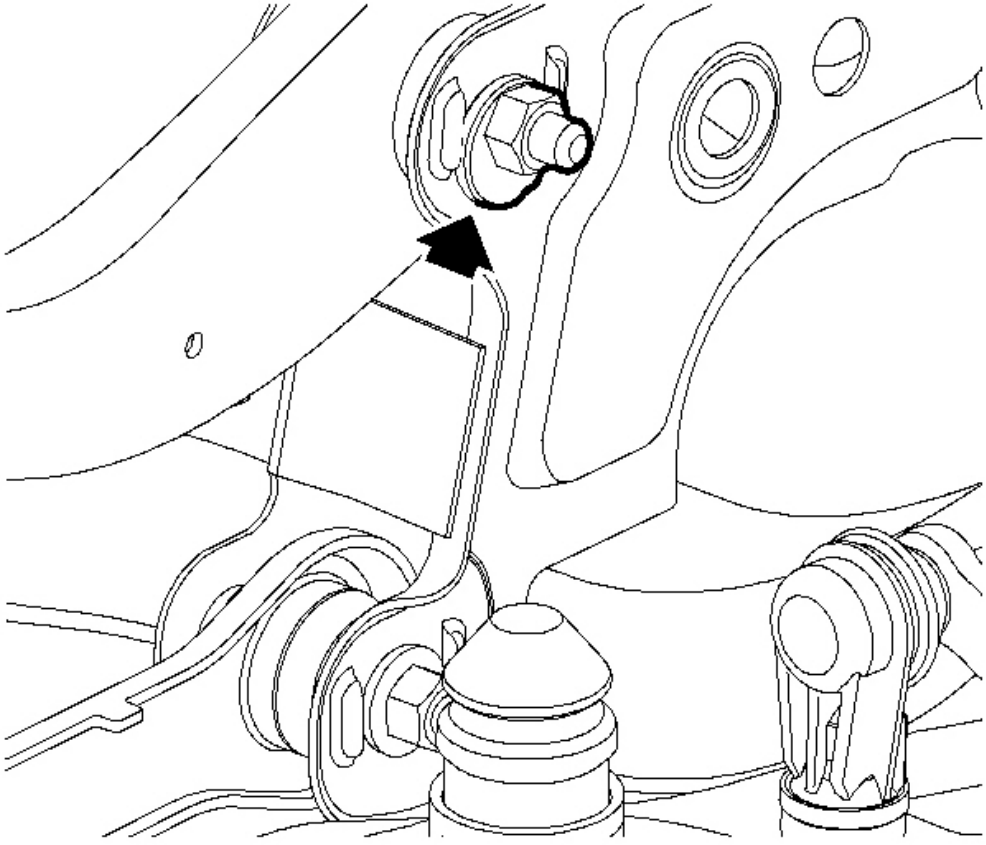

Fig. 6: Upper Control Arm-To-Frame Fastener
Courtesy of GENERAL MOTORS CORP.

1. Loosen the upper control arm-to-frame fastener enough to allow movement.

IMPORTANT: The frame of the vehicle is slotted, turning the cam nut will move the camber in to the designated location.

2. Rotate the upper control arm-to-frame fastener in the direction necessary to the correct the camber measurement.
3. Snug the upper control arm-to-frame fastener, do not tighten at this time.
4. Reinspect the rear camber specifications and adjust as necessary.

NOTE: Refer to Fastener Notice in Cautions and Notices.

5. Hold the nut and tighten the upper control arm-to-frame bolt.

   Tighten: Tighten the bolt to 110 N.m (81 lb ft).

6. Repeat the procedure for the other rear wheel.

REAR TOE ADJUSTMENT

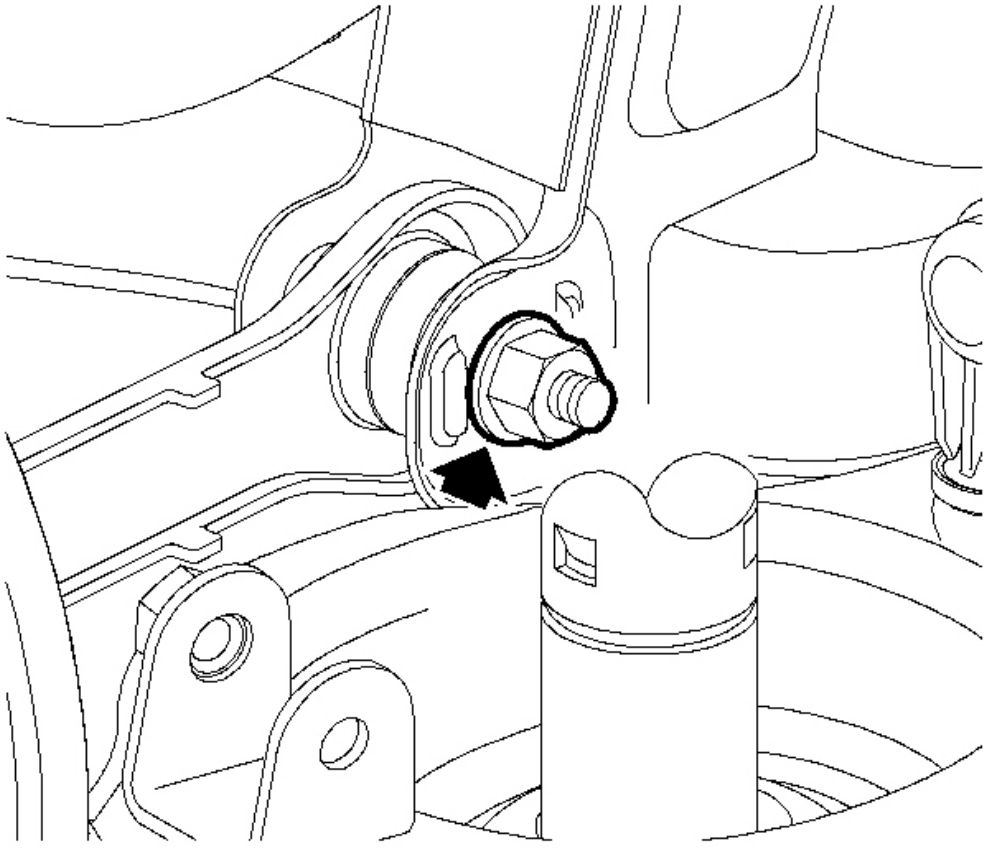

Fig. 7: Toe Link-To-Frame Fastener
Courtesy of GENERAL MOTORS CORP.

1. Loosen the toe link-to-frame fastener enough to allow for movement.

IMPORTANT: The frame of the vehicle is slotted, a cam nut is available for service if required.

2. Rotate the toe link cam nut in the direction necessary to correct the toe angle.
3. Snug the toe link-to-frame fastener, do not tighten at this time.
4. Reinspect the rear toe specifications and adjust as necessary.

NOTE: **Refer to Fastener Notice in Cautions and Notices.**

5. Hold the nut and tighten the link-to-frame fastener bolt.

   Tighten: Tighten the bolt to 110 N.m (81 lb ft).

6. Repeat the procedure for the other rear wheel.

DESCRIPTION AND OPERATION

CASTER DESCRIPTION

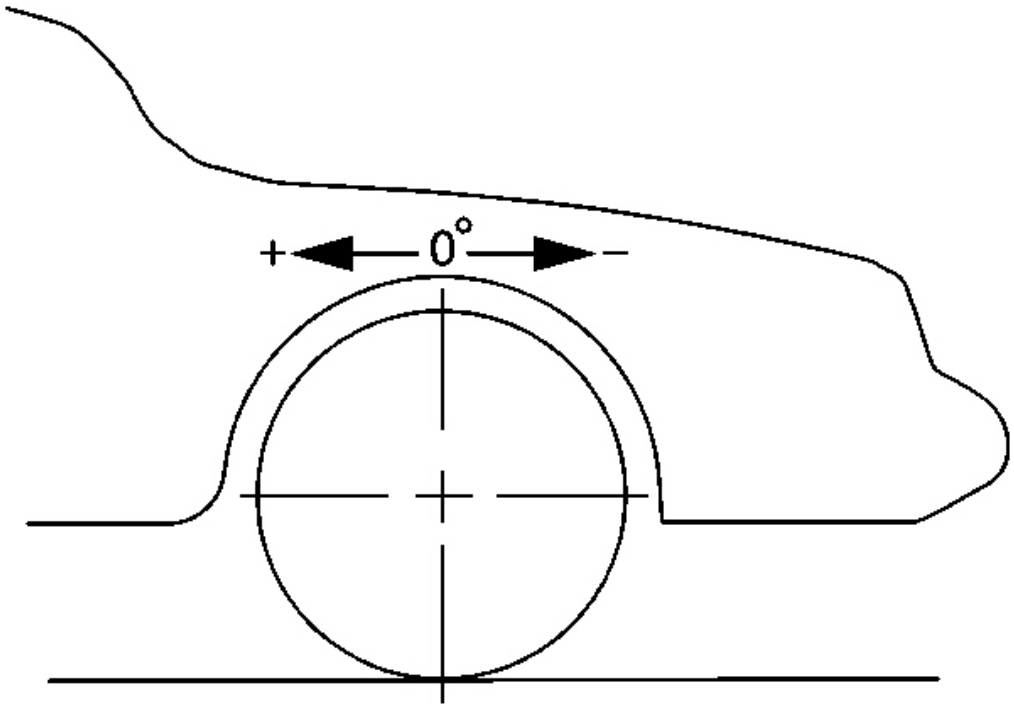

Fig. 8: Illustrating Caster Angle
Courtesy of GENERAL MOTORS CORP.

Caster is the tilting of the uppermost point of the steering axis either forward or backward, 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 the tire wear. Caster is affected by the vehicle height, therefore it is important to keep the body at its designed height. Overloading the vehicle or a weak or sagging rear spring will affect caster. When the rear of the vehicle is lower than its designated trim height, the front

suspension moves to a more positive caster. If the rear of the vehicle is higher than its designated trim height, the front suspension moves to a less positive caster.

With too little positive caster, steering may be touchy at high speed and wheel returnability may be diminished when coming out of a turn. If one wheel has more positive caster than the other, that wheel will pull toward the center of the vehicle. This condition will cause the vehicle to pull or lead to the side with the least amount of positive caster.

CAMBER DESCRIPTION

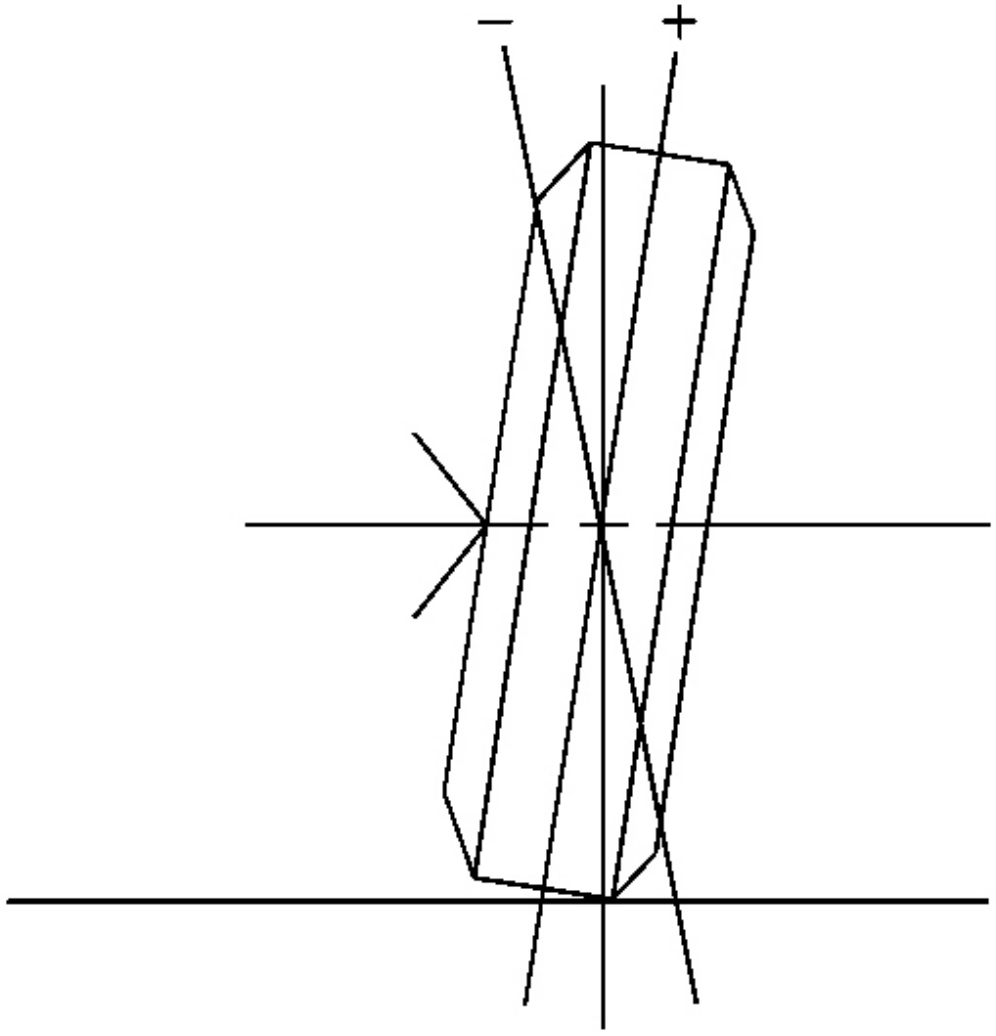

Fig. 9: Illustrating Camber Angle
Courtesy of GENERAL MOTORS CORP.

Camber is the tilting of the wheels from the vertical when viewed from the front of the vehicle. When the wheels tilt outward at the top, the camber is positive (+). When the wheel tilts inward at the top, the camber is negative (-). The amount of tilt is measured in degrees from the vertical. Camber settings influence the directional control and the tire wear.

Too much positive camber will result in premature wear on the outside of the tire and cause excessive wear on the suspension parts.

Too much negative camber will result in premature wear on the inside of the tire and cause excessive wear on the suspension parts.

Unequal side-to-side camber of 1 degree or more will cause the vehicle to pull or lead to the side with the most positive camber.

TOE DESCRIPTION

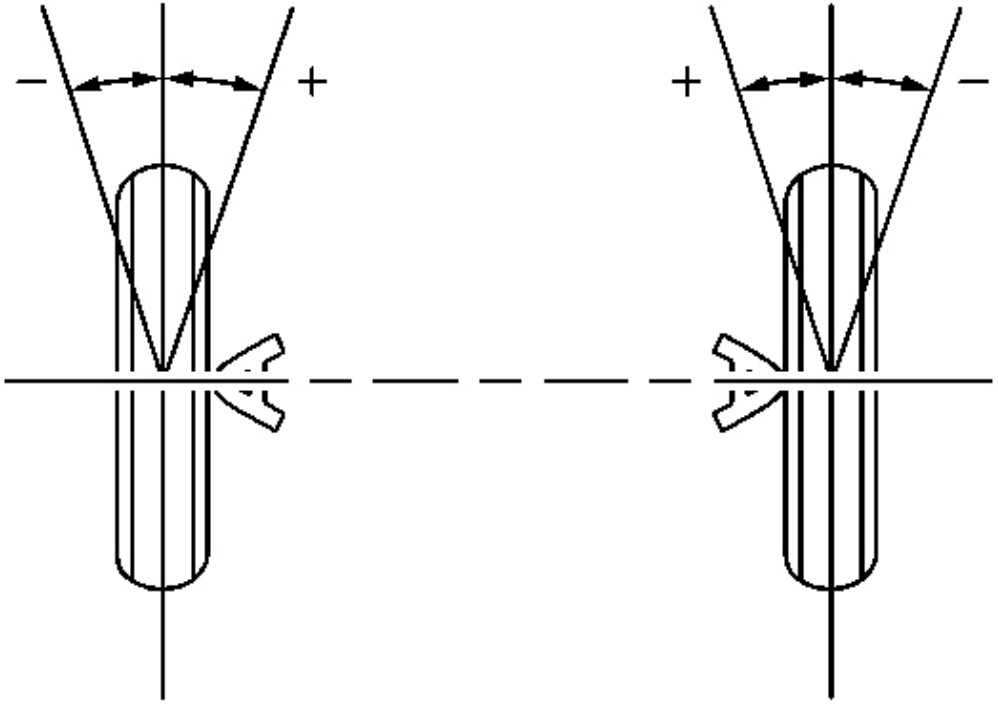

Fig. 10: Illustrating Toe
Courtesy of GENERAL MOTORS CORP.

Toe is a measurement of how much the front and/or rear wheels are turned in or out from a straight-ahead position. When the wheels are turned in, toe is positive (+). When the wheels are turned out, toe is negative (-). The actual amount of toe is normally only a fraction of a degree. The purpose of toe is to ensure that the wheels roll parallel.

Toe also offsets the small deflections of the wheel support system that occur when the vehicle is rolling forward. In other words, with the vehicle standing still and the wheels set with toe-in, the wheels tend to roll parallel on the road when the vehicle is moving.

Improper toe adjustment will cause premature tire wear and cause steering instability.

THRUST ANGLES DESCRIPTION

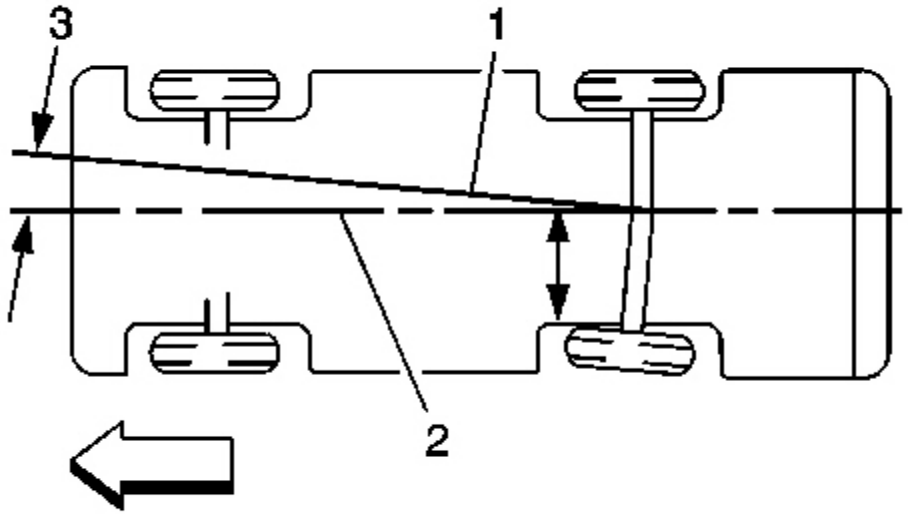

Fig. 11: Illustrating Thrust Angles
Courtesy of GENERAL MOTORS CORP.

The front wheels aim or steer the vehicle. The rear wheels control tracking. This tracking action relates to the thrust angle (3). The thrust angle is the path that the rear wheels take. Ideally, the thrust angle is geometrically aligned with the body centerline (2).

In the illustration, toe-in is shown on the left rear wheel, moving the thrust line (1) off center. The resulting

deviation from the centerline is the thrust angle.

If the thrust angle is not set properly the vehicle may "dog track", the steering wheel may not be centered or it could be perceived as a bent axle. Thrust angle can be checked during a wheel alignment.

Positive thrust angle means the thrust line is pointing to the right hand side (RHS) of the vehicle.

Negative thrust angle means the thrust line is pointing to the left hand side (LHS) of the vehicle.

If the thrust angle is out of specification, moving the axle to body relationship will change the thrust angle reading.

If the vehicle is out in the Positive (+) direction-moving the RHS forward and/or LHS rearward will move the thrust angle towards zero degrees.

If the vehicle is out in the Negative (-) direction-moving the RHS rearward and/or LHS forward will move the thrust angle towards zero degrees.

LEAD/PULL DESCRIPTION

At a constant highway speed on a typical straight road, lead/pull is the amount of effort required at the steering wheel to maintain the vehicle's straight path.

Lead/pull is usually caused by the following factors:

- Tire construction
- Wheel alignment
- Unbalanced steering gear

The way in which a tire is built may produce lead/pull. The rear tires will not cause lead.

TORQUE STEER DESCRIPTION

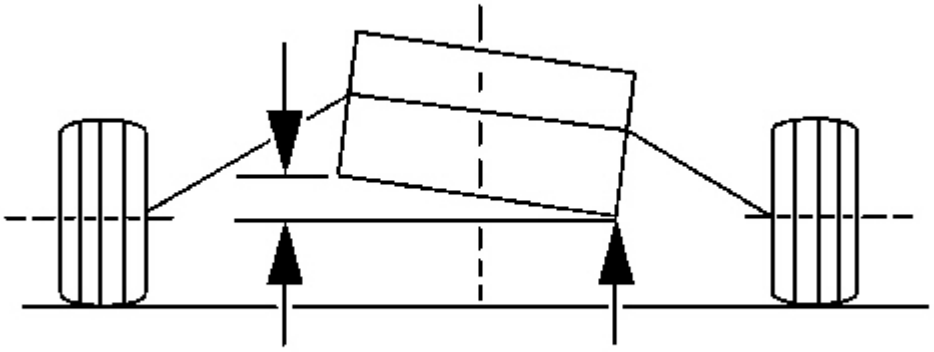

Fig. 12: Identifying Torque Steer
Courtesy of GENERAL MOTORS CORP.

A vehicle pulls or leads in one direction during hard acceleration. A vehicle pulls or leads in the other direction during deceleration.

The following factors may cause torque steer to be more apparent on a particular vehicle:

- A slightly smaller diameter tire on the right front increases a right torque lead. Inspect the front tires for differences in the brand, the construction, or the size. If the tires appear to be similar, change the front tires from side-to-side and retest the vehicle. Tire and wheel assemblies have the most significant effect on torque steer correction.
- A large difference in the right and left front tire pressure
- Left-to-right differences in the front view axle angle may cause significant steering pull in a vehicle. The pull will be to the side with the most downward sloping axle from the differential to the wheels. Axles typically slope downward from the differential. The slope of the transaxle pan to level ground may be used as an indication of bias axle angles. The side with the higher transaxle pan (shown on the left side of the illustration) has the most downward sloping axle angle.

MEMORY STEER DESCRIPTION

Memory steer is when the vehicle wants to lead or pull in the direction the driver previously turned the vehicle. Additionally, after turning in the opposite direction, the vehicle will want to lead or pull in that direction.

WANDER DESCRIPTION

Wander is the undesired drifting or deviation of a vehicle to either side from a straight path with hand pressure on the steering wheel. Wander is a symptom of the vehicle's sensitivity to external disturbances, such as road

crown and crosswind, and accentuated by poor on-center steering feel.

SCRUB RADIUS DESCRIPTION

Ideally, the scrub radius is as small as possible. Normally, the SAI angle and the centerline of the tire and the wheel intersect below the road surface, causing a positive scrub radius. With struts, the SAI angle is much larger than the long arm/short arm type of suspension. This allows the SAI angle to intersect the camber angle above the road surface, forming a negative scrub radius. The smaller the scrub radius, the better the directional stability. Installing aftermarket wheels that have additional offset will dramatically increase the scrub radius. The newly installed wheels may cause the centerline of the tires to move further away from the spindle. This will increase the scrub radius.

A large amount of scrub radius can cause severe shimmy after hitting a bump. Four-wheel drive vehicles with large tires use a steering damper to compensate for an increased scrub radius. Scrub radius is not directly measurable by the conventional methods. Scrub radius is projected geometrically by engineers during the design phase of the suspension.