FOUR WHEEL ALIGNMENT

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Four Wheel Alignment is necessary on today's design vehicles, yet it remains a mystery to most people. Correct Alignment and a properly operating suspension are vital to vehicle control, not only for safety but also for comfort when driving a vehicle. There is a possibility of incorrect rear wheel thrust line, which can cause the vehicle to pull or push in the opposite direction the wheels are pointing.

The minimum effect of incorrect alignment, thrust line and worn or damaged suspension components would be incorrect steering wheel position, rapid tire wear and vehicle pull.

The maximum effect of these conditions would be personal injury and property damage.

It would be impossible to put everything that is needed to know in this article; therefore a basic understanding of alignment terms would be of assistance. In the following I have tried to use basic simple terms and explanations.

TOE -IN

When the front of the wheels are closer together than the rear of the wheels on the same axle.

TOE-OUT

When the front of the wheels are farther apart than the rear of the wheels on the same axle.

TOE-IN or TOE-OUT ANGLE

Angle formed by the difference in distance between the two front wheels when a measurement is taken at both the front and rear of the wheels on the same axle.

The purpose of the toe angle adjustment is to compensate for tolerance in the steering system components, and to counter the coning action of camber on the tires.

Toe angle is adjustable on the front wheels, and on a majority of front wheel drive vehicles provisions are made for adjustment of rear toe.

Toe is the most important alignment adjustment on the vehicle for preventing accelerated tire wear.

Special Note:
An incorrect measurement of 1/8 inch is equal to driving a car one-mile and having the tire dragged sideways eleven feet.

TURNING RADIUS ANGLE (Toe out on turns)

Turning angle is also referred to as toe out on turns. The purpose of the turning radius angle is to steer the vehicle through turns with minimum tire wear. The manufacturer sets this angle by angling the steering arms inward toward the vehicle's centerline and generally it is not adjustable.

When a vehicle turns a corner each front wheel turns independently of the other. The front inner wheel turns more than the outer wheel, creating a smaller diameter circle for the inner wheel. This reduces the sideslip and scuffing off on tires during cornering.

REAR WHEEL STEER

There are two vehicle reference lines that will be considered when examining rear wheel steer. Tire treads width center line and rear wheel thrust line.

REAR WHEEL THRUST LINE

A line dividing the total toe angle into two equal parts. Rear wheel thrust line is also referred to as thrust angle. Incorrect location of rear wheel thrust line will effect the vehicle alignment by:

- - Rear wheel steer right or left
- - Steering wheel clock position error (off centre)
- - Rear tire wear

CAMBER ANGLE

The inward or outward tilt of the wheel at the top.

The purpose of camber is to provide directional control stability by placing the maximum tire tread in contact with the road surface under all conditions of vehicle operation and to prevent tire wear.

All else being equal, a vehicle will pull toward the side with more positive or less negative camber.

CASTER ANGLE

The forward or backward tilt of the steering knuckle at the top.

The purpose of caster angle is to provide directional control stability of the front wheels for travel in a straight course with minimum steering effort, and also to assist in returning the front wheels to the straight ahead position after cornering.

In a MacPherson strut suspension system, caster is does not have a predominant role due to the high SAI angle. Where a vehicle has high SAI angle, this becomes the directional control angle.

Caster can be positive (top of steering axis back) or negative (top of steering axis forward). This is in many cases an adjustable angle. (use of shims, eccentrics or strut rods).

As caster setting is increased to positive, vehicle directional control is also increased. High positive caster may result in low speed shimmy.

As caster setting is decreased to negative, vehicle directional control is decreased but provides easier steering at slow speeds. Low or negative caster may result in sensitive steering at high speeds, which could lead to wander.

Caster is a directional control angle and can be used to offset road crown when adjustable. It has little effect on tire wear and is considered a non-tire-wearing angle

All else being equal, a vehicle will pull toward the side with less positive or more negative caster.

TRACKING ANGLE

Track is when the rear wheels of the vehicle follow the front wheels in a straight-ahead position.

There are three tracking conditions that have effect on the quality of vehicle wheel alignment:

- Front wheels set back
- Rear suspension misalignment
- Body or frame damage

TRACKING PROBLEMS

Set back is designed in from the factory in some front wheel drive vehicles to help eliminate torque steer problems.
If a vehicle has excessive set back it is usually caused by impact to front wheel assembly.

This will effect front wheel alignment by causing:

- Caster angle to change
- Camber angle to change
- Toe angle to change
- Front tire wear
- Steering wheel position change
- Wheel alignment pull

NOTE: On rear wheel drive vehicles, if the rear axle is shifted it will normally result in total rear toe reading of 0 , but with one wheel showing positive toe and the other wheel showing an equal negative toe. This will result in a thrust angle of .25 degrees or greater.

TIRE TREAD WIDTH CENTRE LINE

A line joining centres of the front and rear tire tread widths.
Tire tread width centre line is also referred to as geometric centerline.

A few other terms:

Toe change on Bumps

Caused by the tie rods not being horizontal. As the vehicle moves up and down, the wheels toe in or out. This can happen to rear wheels that have tie rods for toe adjustment.

Bump Steer

Caused by a toe change as a vehicle moves up and down, which causes the vehicle to steer the wheels with the up and down movement of suspension because steering linkage is not level or horizontal.

Roll Steer

Is the steering of the rear wheels from body roll. It is caused by the position of the rear trailing arms or leaf springs.

Conditions effecting vehicle pulling, wander and tire wear

Tire Condition	Power steering Pulls	Torque Steer
Tire Pressure	Memory Steer	Weak or bad springs
Alignment Setting	Vehicle Load	Weak or bad shocks
Tracking Problems	Brake Pull	Worn or Damaged Parts

For those fortunate to have Alignment Equipment the following tables based on my experience may prove to be of some help.

SAI and INCLUDED ANGLE DIAGNOSTIC TABLES

Short and Long Control Arm Suspensions

SAI Angle	Camber Angle	Included Angle	Problem
In Specification	Higher or lower than Specification	Higher or lower than Specification	Bent Spindle

Lower than Specification	Lower than Specification	In specification	Bent Lower Control arm
Higher than Specification	Lower than Specification	In specification	Bent Upper Control arm
Lower than Specification	Higher than Specification	Higher than Specification	Bent Lower Control arm and Spindle

Ford Twin I-Beam Suspension

SAI Angle	Camber Angle	Included Angle	Problem
In Specification	Higher or Lower than Specification	Higher or Lower than Specification	Bent Spindle
Lower than Specification	Higher than Specification	In Specification	Bent I-beam
Higher than Specification	Lower than Specification	In Specification	Bent I-beam
Lower than Specification	Higher than Specification	Higher than Specification	Bent I-beam and Spindle

Macpherson Strut Suspension

SAI Angle	Camber Angle	Included Angle	Problem
In Specification	Lower than Specification	Lower than Specification	Bent spindle and /or bent strut body
In Specification	Higher than Specification	In Specification	Bent spindle and /or bent strut body
Higher than Specification	Lower than Specification	In specification	Strut tower at top
Higher than Specification	Higher than Specification	Higher than Specification	Strut tower in at top and spindle and /or strut body bent
Lower than Specification	Higher than Specification	In Specification	Bent Control arm or strut tower out at top
Lower than Specification	Higher than Specification	Higher than Specification	Bent control arm or strut tower out at top plus bent spindle and /or strut body
Lower than Specification	Lower than specification	Lower than specification	Strut tower out at top and spindle and/or strut body bent or bent control arm

CHECK OF SUSPENSION AND STEERING SYSTEMS

DAMAGE ANALYSIS

(All checks should be made in this order)

Rebound Toe-in - *Checks for misalignment of the Rack and pinion Steering gear.*

1. Make reference of toe readings.
2. Bounce and rebound suspension while observing the toe readings. If no toe change is noticed when either side is tested, steering gear alignment is good.
3. If toe change is noticed when the right or left side is checked. Steering gear is likely misarranged.

Cornering Turning Angle - *To check the condition of the steering arms and spindle.*

1. Use turning radius gauges
2. Turn the left wheel outboard approximately 20 degrees record the turning angle on the right

wheel.
3. Turn the right wheel outboard approximately 20 degrees record the turning angle on the left wheel.
4. If your bounce and rebound toe check said you had a problem and the turning angle check you made are equal from side to side, you have a misalign steering gear.

Camber Check - *To determine the condition of the strut (inboard /outboard damage)*

1. Load the suspension system. Pull down on bumper of vehicle lowering suspension.
2. Record camber reading from display on screen.
3. Unload suspension and lift up on the vehicle slightly. Make a second reference camber check and record.
4. Compare the two readings. They should be equal + or - ½ degree.
5. If strut is bent inboard or outboard, the readings will change significantly. A change of 4 to 5 degrees is not uncommon.
6. Take care to make both readings in the same place on the wheel.

Swing Camber Check - *To determine the condition of the strut forward or rear ward.*

1. Use the complete readout screen and record right wheel camber reading.
2. Turn the wheel outboard 15 degrees, take a camber reading.
3. Turn the wheel inboard 15 degrees, take a camber reading. If the strut is not bent forward or rearward, little difference will appear between the readings. (Usually less than 4 ½ degrees).
4. If the strut is bent forward or rearward a large difference will appear between the readings. (A 10-degree difference is not uncommon).
5. When rotating the wheel thru an arc, if the strut is bent either forward or rearward you will see a significant camber change.

NOTE:

This is intended to cast some light on the mystery of Alignment and Suspensions. By no means is it complete or will it make one a Suspension expert. Therefore take what you can get from it and if you have any helpful comments or additions that you feel will help others send them to me and if they bear merit I will add them to this article.

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