

## Diagnosing Bent Steering and Suspension Components Using Steering Geometry Angles

Camber is one of the most commonly adjusted alignment geometry angles and 95% of all faults are corrected by normal alignment methods. However in the other 5% of cases, location of damaged components can prove difficult and time consuming. More importantly, incorrect diagnosis and repair of the camber faults may lead to far more serious ramifications. This issue of Tech Stop, shows how alignment angles can be used to indicate where the damaged component is, what to replace and how to achieve correct alignment geometry angles.

There are a number of potential causes of camber faults including movement within the bushes; wear in the joints; ride height changes; flex from within the chassis; or a combination of the above.

As we have mentioned, normal adjustment will correct the great majority of these faults. Our purpose here is to show how the use of alignment angles, can make it easy to identify problems.

We do this by making use of alignment angles to effectively divide the suspension into two halves. The alignment figures will tell us in which half of the suspension the fault will be found.

The alignment angles we use to do this are Camber, S.A.I. (Steering Axis Inclination) and I.A. (Included Angle). S.A.I., also known as King Pin Inclination (K.P.I.), is the angle between the true vertical and a line drawn through the centre of the strut's top pivot (or upper ball joint) and the lower ball joint. It is sometimes difficult to obtain an OE specification on S.A.I. and so we recommend keeping a record of SAI angles to obtain an average figure which becomes your specification for a particular vehicle.

I.A. is the angle between the S.A.I. and camber line when viewed from the front. We cannot measure I.A. directly and so we calculate it by adding or subtracting the actual camber from the S.A.I.. This explains the term 'Included Angle' as you need to include camber with the S.A.I. to get the I.A.. When camber is positive, add it to the S.A.I. angle. If camber is negative, subtract it from the S.A.I. to obtain the I.A..

### Here are two examples:

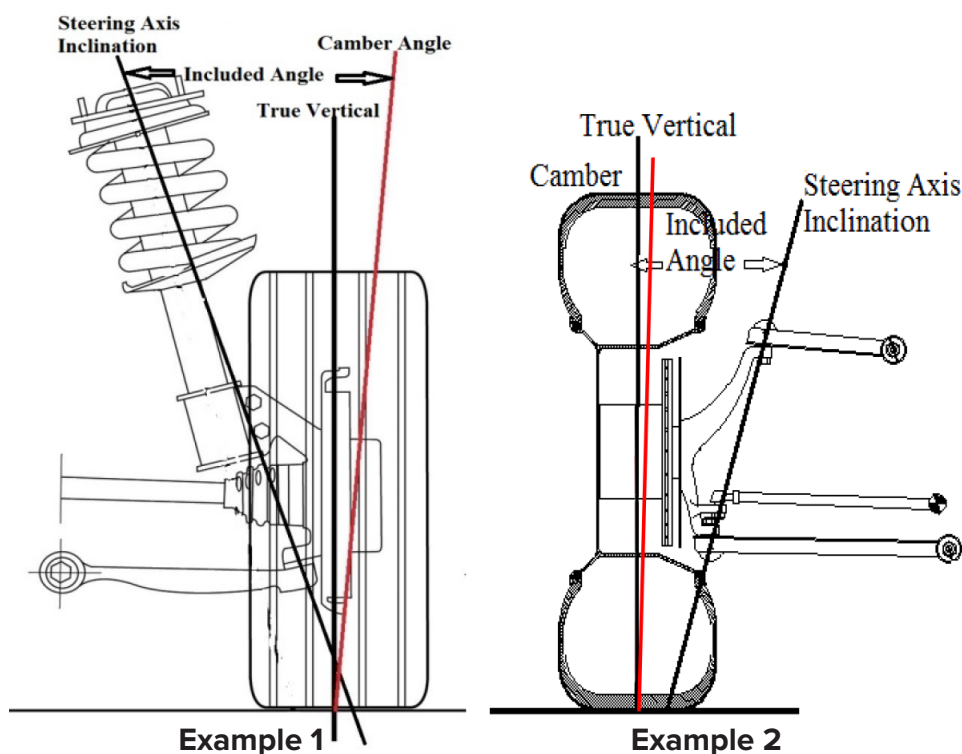
$S.A.I. + \text{Camber} = I.A.$

1.  $S.A.I. = 9^\circ$        $\text{Camber} = +1^\circ$

$I.A. = 9^\circ + 1^\circ = 10^\circ$

2.  $S.A.I. = 11^\circ$        $\text{Camber} = -1^\circ$

$I.A. = 11^\circ + -1^\circ = 10^\circ$



# DIAGNOSING AND REPAIRING BENT SUSPENSION COMPONENTS

SHOCK ABSORBER, SUSPENSION, BRAKES, TOWBARS  
AND WHEEL ALIGNMENT SPECIALISTS

The S.A.I. and I.A. are very good wheel alignment geometry angles to use as diagnostic tools for vehicles that are not producing alignment figures consistent with the O.E. specifications. It helps you determine if a component is bent and where it is located.

If the S.A.I. is at the OE specification, (on average 13° to 14°), we can be certain that the problem is outboard of the steering axis pivots. If the S.A.I. is greater or less than the OE spec, then the problem will lie inboard of the steering axis pivots, one of the pivots has moved (or both).

In twin lateral arm suspension the steering axis pivot is the centre line drawn between the upper and lower ball joints. On a MacPherson or Chapman strut suspensions, the steering axis pivot is the centre point of the top pivot bearing and the centre of the lower ball joint.

## Example 1.

A car with MacPherson Strut suspension has the following camber readings:

RH = -1° LH = +1° 10' OE spec = +1°

The vehicle was involved in an accident and we need to determine what damage has been done to the alignment. A visual inspection reveals no difference between the left and right suspension components.

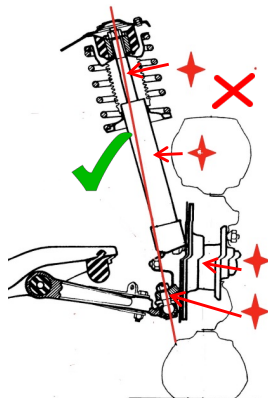
By checking the S.A.I., the following was noted:

RH = 7° 15' LH = 7° 00' OE spec = 7°

The S.A.I. on both sides are within specs.

From the camber and S.A.I. readings, we can calculate the Included Angle.

RH 6° LH 8° 10'



Example 1

The Included Angle on the LH side is within OE specs, but the RH side is 2° out. Because the RH side S.A.I. is to specification but its Included Angle is incorrect, we know that the fault exists outboard from the steering axis pivots.

The components that are outboard from the steering axis pivots are the ball joint stud, the strut shaft, the strut body and the forged stub axle or the knuckle assembly.

We know that the fault does not exist inboard from the steering axis pivots. Thus the following components will be in correct alignment: the ball joint seat, lower control arm, lower inner bush, chassis rail, strut tower and top bearing plate.

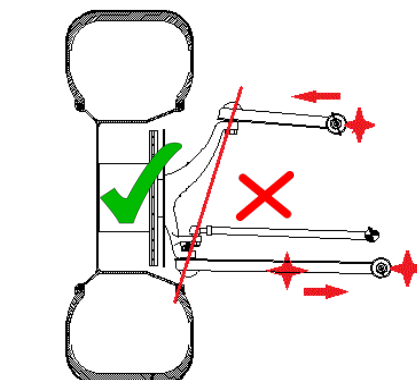
## Example 2.

A vehicle with twin lateral arm suspension has the following wheel alignment specifications:

	RH	LH	OE
Camber 2°	20'	-0° 20'	-0° 15'
S.A.I.	5° 55'	8°30'	8°35'
I.A.	8° 15'	8° 10'	8°20'

This vehicle obviously has a camber problem, but the Included Angle is to specification. Because of this we know that all the components between the two steering pivots and the wheel are in correct alignment.

This means the problem is inboard of the steering axis pivots. The possible faults are a bent chassis, incorrectly positioned ball joints, stretched top arm, bent lower arm, worn upper or lower pivot bushes.



Example 2

## Incorrect Diagnosis May Cause Other Problems

If a problem is incorrectly diagnosed and an incorrect repair made, then the original problem is solved and a new problem appears. The following is an example of this.

A Commodore has the following angles:

	RH	LH
Camber	-2°	-0.50°

Both bearing plates are positioned for the lowest camber and highest caster. From this information and previous experience, the mechanic diagnosed it as a bent strut and it was given a camber correction of 1.50°. This solves the camber problem and tyre wear, but has caused a possibly more serious one. If the S.A.I. and the I.A. had been checked, the mechanic would have found the following:

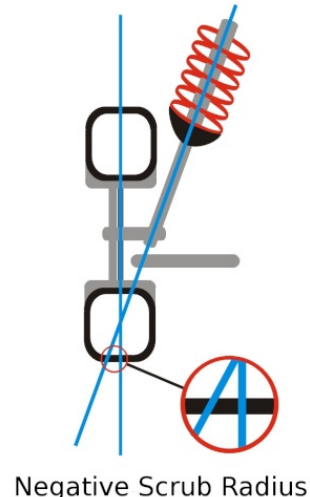
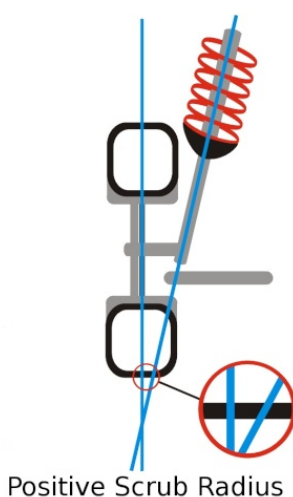
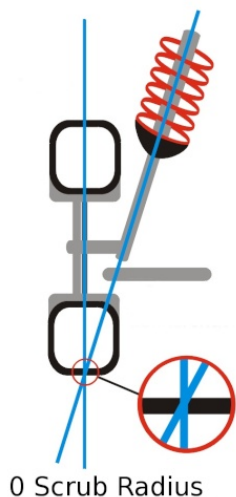
Scrub radius or scrub distance is the distance between the centre of the tyre's footprint and the point at which the steering axis meets the road surface. Zero or neutral scrub radius is when the steering axis meets the road surface at the centre of the tyre's footprint. Scrub radius is positive when the steering axis meets the road inboard of the centre of the footprint; and it is negative when the steering axis meets the road outboard of the tyre's centre.

It is the scrub distance that effects feedback to the driver through the steering wheel. A vehicle with zero scrub distance has poor directional stability and very little feedback.

Most rear wheel drive vehicles have positive scrub radius of between 25 - 50mm and all modern front wheel drives have negative scrub radius of 2 - 6mm. The change from positive to negative scrub radius resulted from the introduction of diagonal split braking systems.

Positive scrub radius causes the wheel to pull outwards and the opposite is true for negative scrub radius. When a front brake fails on a RWD vehicle, severe brake pull can occur. When a front brake fails on a FWD vehicle, the chassis would still try to pivot around the wheel which is braking, but because it has a negative scrub radius the wheel will try to turn in, thus counteracting the pivoting of the chassis. The result - the vehicle stops in a straight line.

This explains why an incorrect diagnosis which changes the I.A. and hence the Scrub Radius can turn a simple alignment fault into a far more dangerous problem.



# DIAGNOSING AND REPAIRING BENT SUSPENSION COMPONENTS

SHOCK ABSORBER, SUSPENSION, BRAKES, TOWBARS  
AND WHEEL ALIGNMENT SPECIALISTS

## Handy Hints

One of the easiest ways of doing a preliminary check of the wheel base, is to check the gap between the tyre and the guard, using your fingers. If there is any noticeable variation then its time to get the tape measure and start checking accurately.

A shorter wheel base on one side of the car usually indicates that an impact has occurred and further inspection is required. One of the indicators that there may be a problem, is that the Caster angles differ from left to right.

If you are having problems finding the source of a Camber fault, check to see that the ball joint has been bent. To confirm this, remove the stud from the taper and inspect it.

Live axle housings can bend, so make sure that the rear geometry angles are checked as well.

At Pedders, we look after suspension fault diagnosis on a daily basis. So talk to your local Pedders Suspension outlet for all your suspension and brake needs.

## Common Alignment Problems with Double Wishbone Suspension.

S.A.I	Camber	I.A.	Problem
OK	Less than specification	Less than specification	Bent spindle or upright, bent ball joint stud
Less than specification	Greater than specification	OK	Bent lower control arm, sub frame moved
Greater than specification	Less than specification	OK	Bent upper control arm, sub frame moved
Less than specification	Greater than specification	Greater than specification	Bent lower control arm as well as bent spindle or ball joint

## Common Alignment Problems with Strut Type Suspensions.

S.A.I	Camber	I.A.	Problem
OK	Less than specification	Less than specification	Bent spindle and/or bent body and /or Bent ball joint stud
OK	Greater than specification	Greater than specification	Bent spindle and/or bent strut body and/or bent ball joint stud
Less than specification	Greater than specification	OK	Bent lower control arm or strut out at top
Greater than specification	Less than specification	OK	Strut tower in at top
Greater than specification	Greater than specification	Greater than specification	Bent control arm or strut tower in at top as well as bent spindle or strut body
Less than specification	Greater than specification	Greater than specification	Bent lower control arm or tower in at top Plus bent spindle or strut body
Less than specification	Less than specification	Less than specification	Bent lower control arm or tower out at top plus bent spindle or strut body