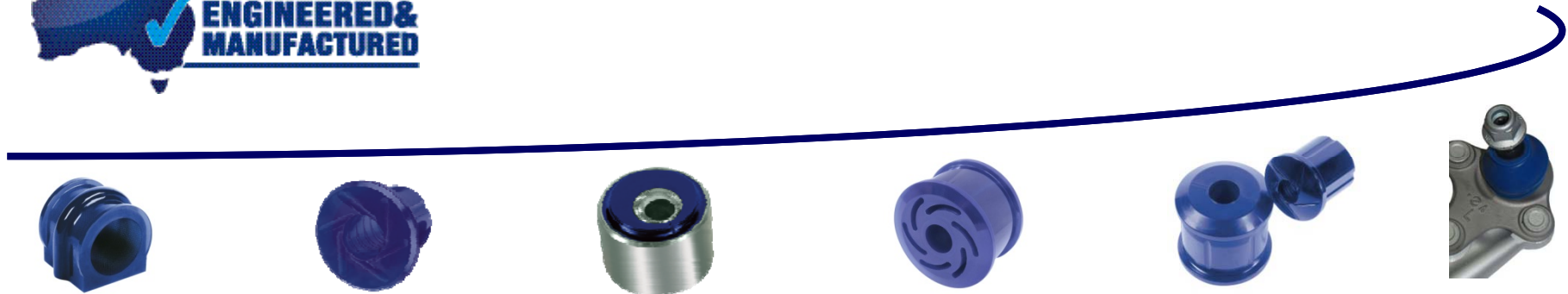




# Understanding Steering and Wheel Alignment Angles

Prepared by  
Graham from SuperPro  
August 2011



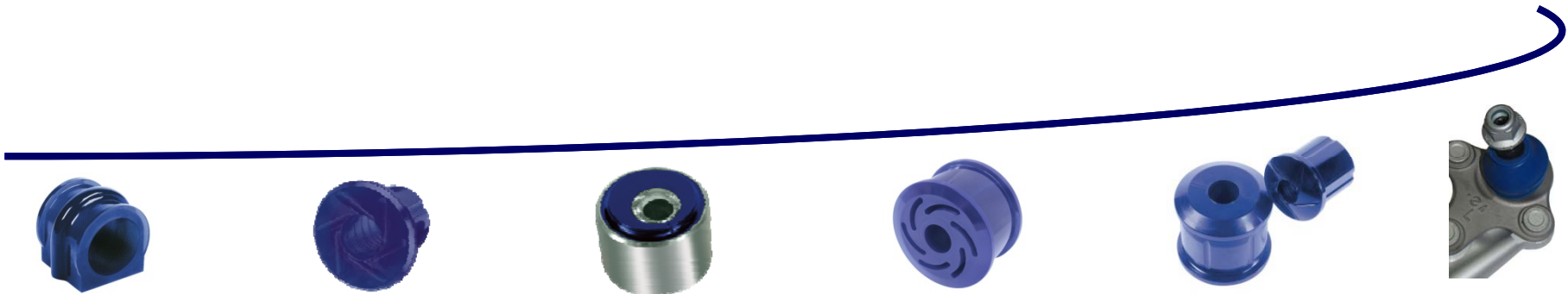


## Understanding Steering & Wheel Alignment Angles

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**Remember:- Tyre Wear Patterns Tell The Technician A Story**

- Provide Vital Information For Determining Final Alignment Settings



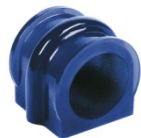


## Understanding Steering & Wheel Alignment Angles

[www.SuperPro.com.au](http://www.SuperPro.com.au)

### Steering Angles Affecting A Vehicles Alignment

- Caster
  - Camber
    - S.A.I.
      - Included Angle
        - Thrust Angle
          - Toe-In And Toe-Out



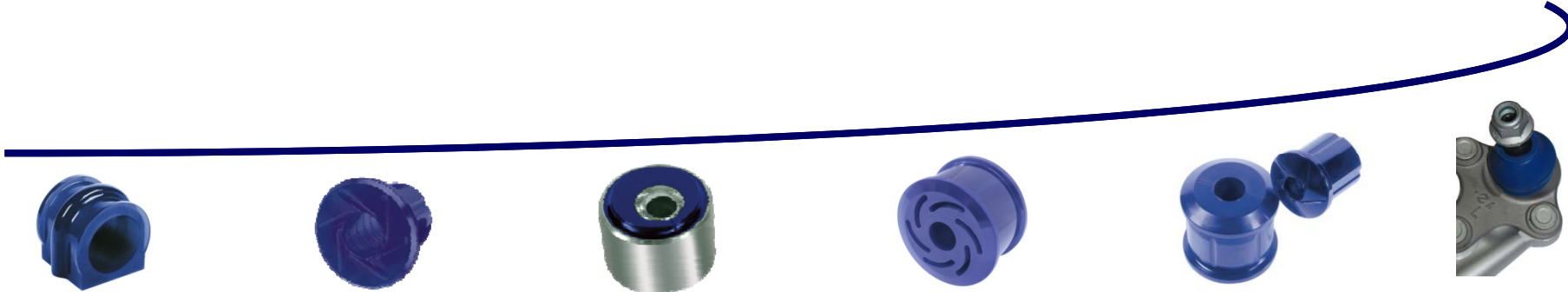


## Understanding Steering & Wheel Alignment Angles

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### Other Factors Related To Tracking, Stability And Tyre Life

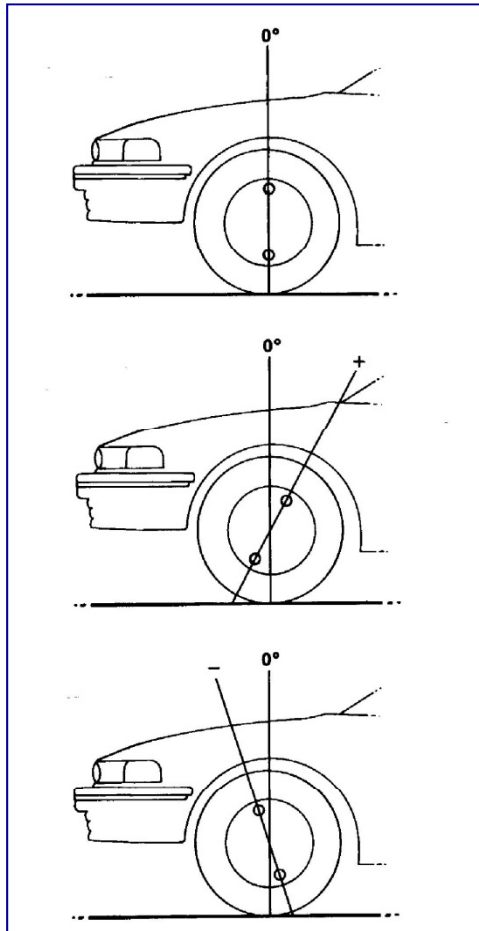
- Set Back
  - Toe Out On Turns
    - Bump Steer
      - Scrub Radius And Wheel Offset



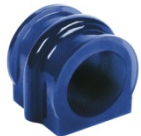


## Understanding Steering & Wheel Alignment Angles

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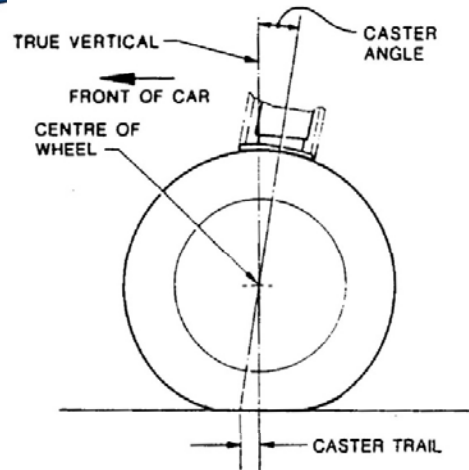
- Caster Is Not A Tyre Wearing Angle
- Caster Assists In the Self Centering Action Of The Steering
- Caster Is The Angle Formed By A Line Through The Pivot Points And A Vertical Line Through The Stub Axle
- Caster Can Be Positive Or Negative
- Excessive Variation Side To Side Vehicle Will Pull To The side Of Least Positive Caster
- Caster Provides Vehicle Stability





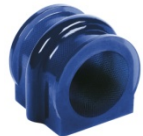
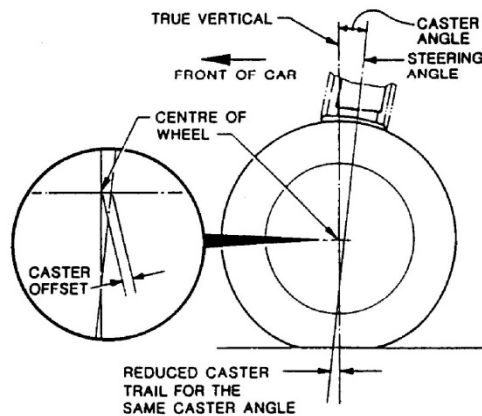
# Understanding Steering & Wheel Alignment Angles

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## Caster Trail Correction For High Caster Angles

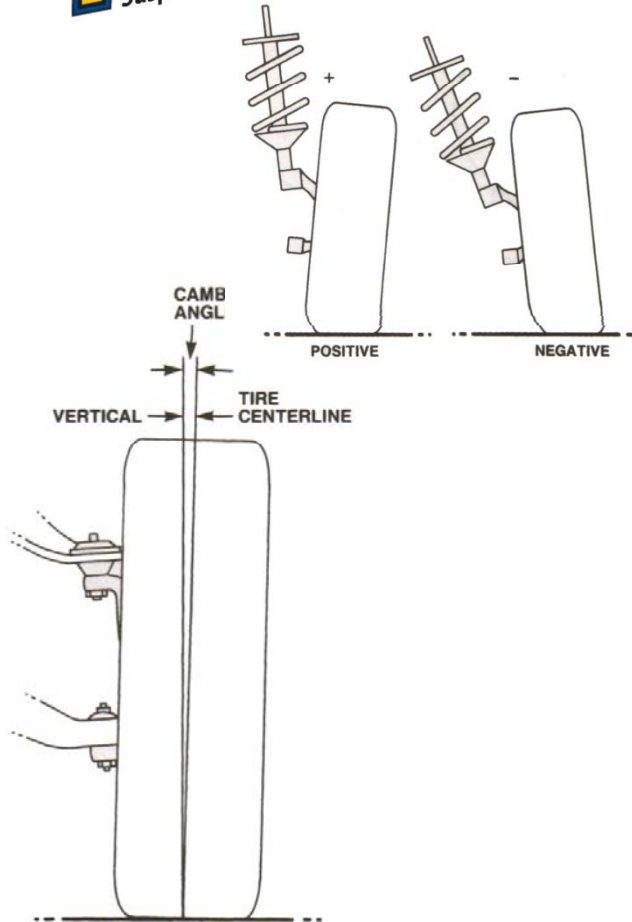
- Ford Falcon AU And Commodore VT Run High Caster Angles
- Reducing Caster Trail Prevents Low Speed Shimmy
- Maintains High Speed Stability





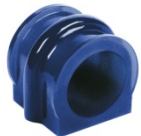
## Understanding Steering & Wheel Alignment Angles

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### Camber

- Camber Is A Tyre Wearing Angle
- Camber Can Be Negative Or Positive
- Positive Camber Tyre And Wheel Assembly Leans Outwards At The Top
- Negative Camber Leans Inwards At The Top
- Negative Camber Provides Full Footprint When Cornering
- Camber Settings A Compromise Between Good Handling And Tyre Wear





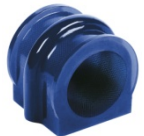


## Understanding Steering & Wheel Alignment Angles

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### Effects Of Camber

- Too Much Positive Wears Outside Of Tyre Tread
- Too Much Negative Wears Inside Of Tyre Tread
- Excessive Variation Side To Side Will Pull To Most Positive
- Excessive Negative Camber Stresses Outer Wheel Bearing
- Excessive Positive Camber Stresses Inner Wheel Bearing





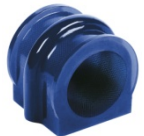


Understanding Steering & Wheel Alignment Angles

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# Influences Of Camber

- Uneven Loading Of Vehicle
- Body Roll In Turns
- Road Camber
- Conditions Of Suspension
- Ride Height Of Each Spring
- Caster

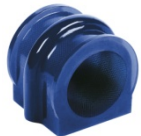
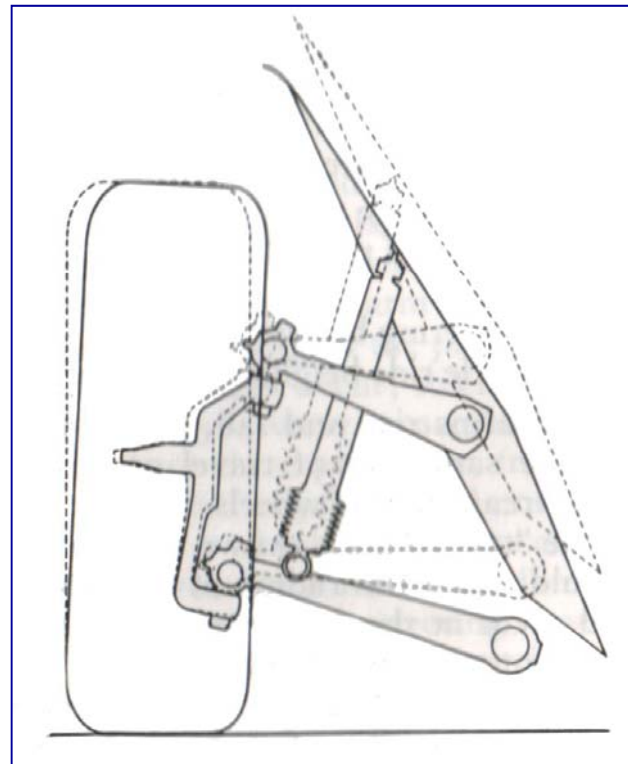




# Understanding Steering & Wheel Alignment Angles

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## Variation In Camber With Change In Ride Height

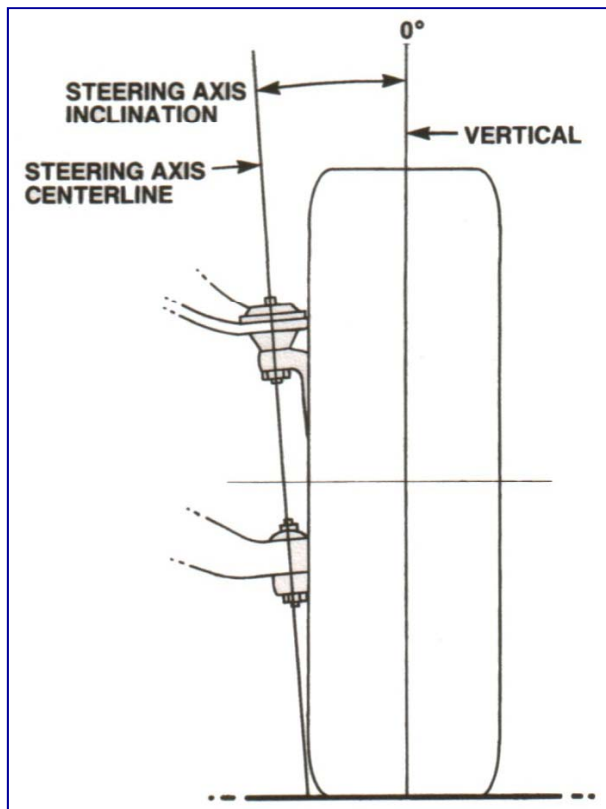




## Understanding Steering & Wheel Alignment Angles

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### Steering Axis Inclination [S.A.I.]

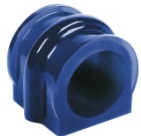


- Angle Formed Between Pivot Points And Vertical Line Through Center Of Wheel

- S.A.I. Is Not Adjustable

- S.A.I. Is A Diagnostic Angle

- Assists Steering Returnability

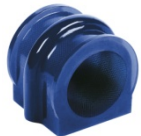
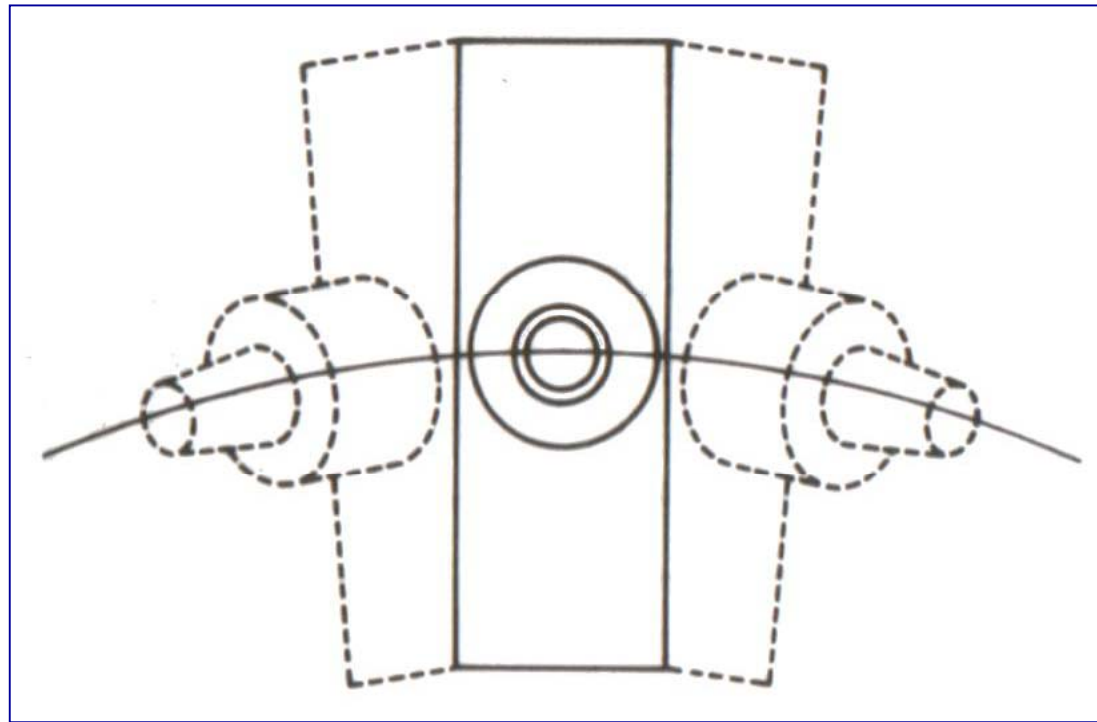




## Understanding Steering & Wheel Alignment Angles

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### Arc Formed By Stub Axle Traversing Lock To Lock

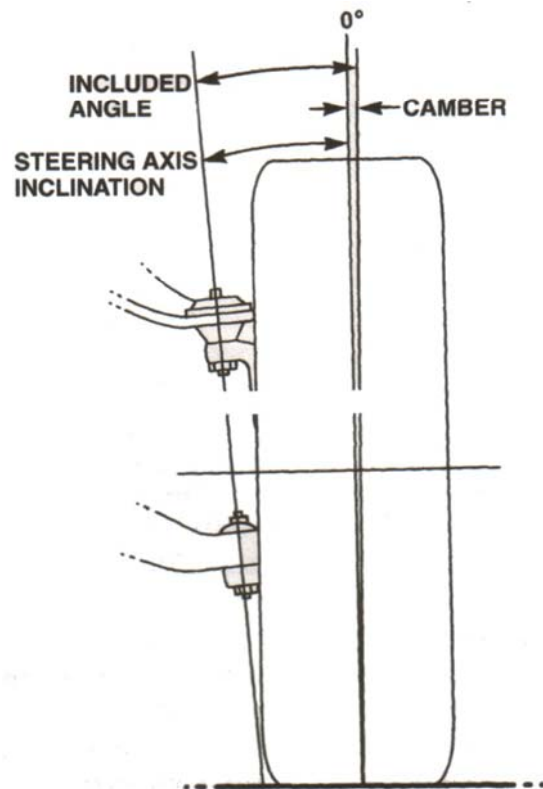




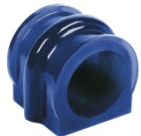
## Understanding Steering & Wheel Alignment Angles

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# Included Angle. A Diagnostic Angle



- Included Angle Obtained By:-
- Adding Positive Camber To S.A.I.
- Subtracting Negative Camber From S.A.I.

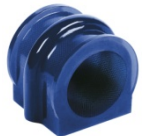
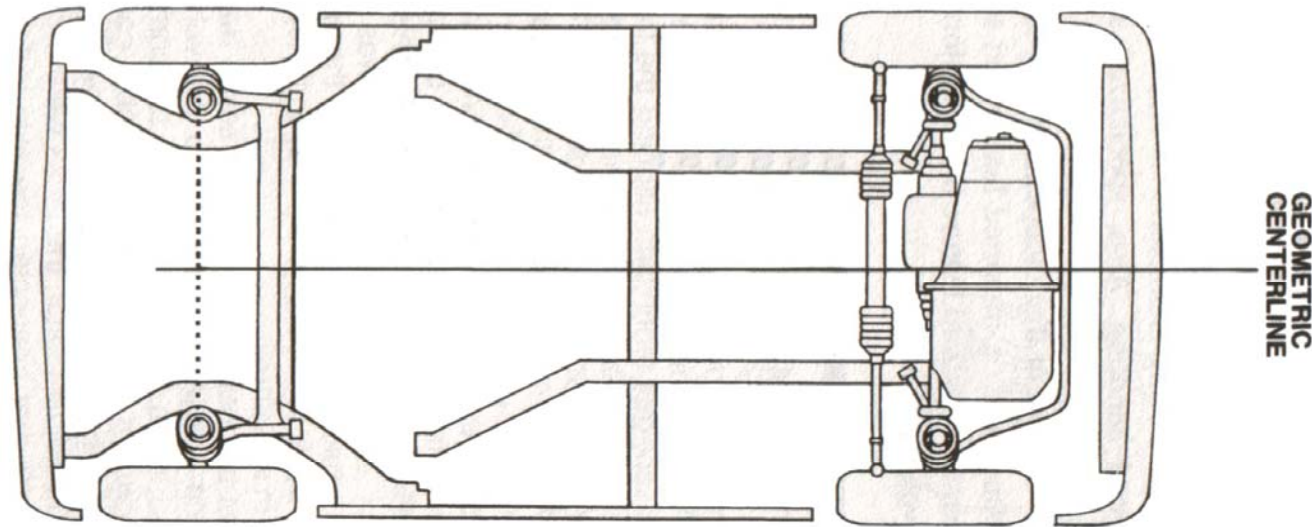




# Understanding Steering & Wheel Alignment Angles

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## Geometric Centre Line Of Vehicle

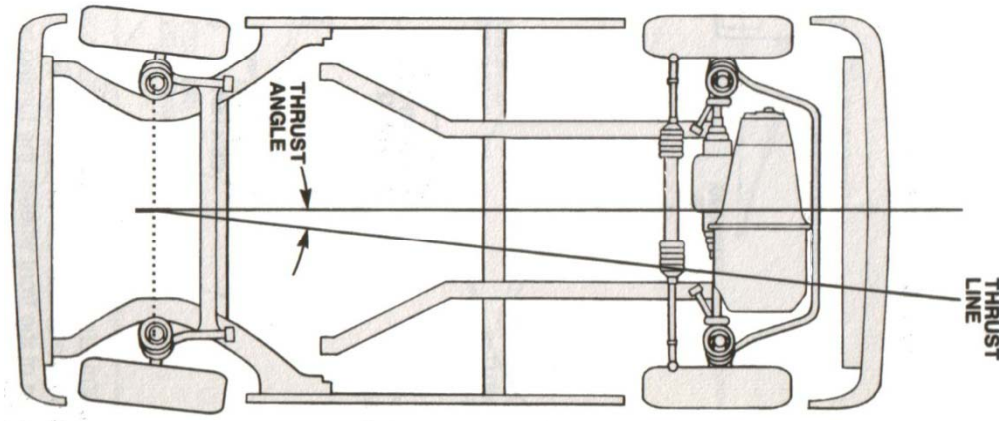




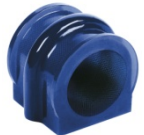


## Understanding Steering & Wheel Alignment Angles

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- Thrust Angle Off Centreline Of Vehicle
- Thrust Angle Of Vehicle Must Be on Centreline
- Rear Toe Adjustment Will Correct Thrust Angle





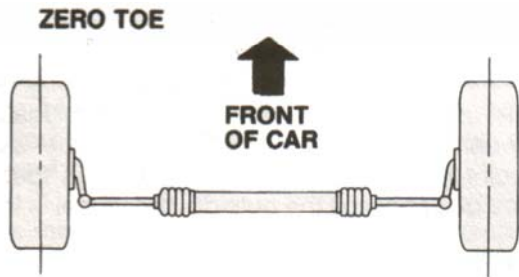


## Understanding Steering & Wheel Alignment Angles

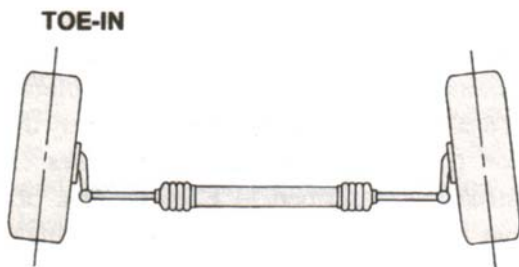
[www.SuperPro.com.au](http://www.SuperPro.com.au)

# Various Toe Settings

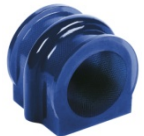
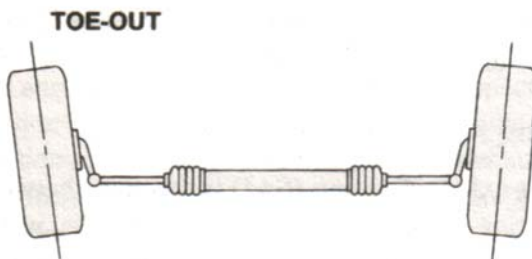
- Zero Toe



- Toe In



- Toe Out

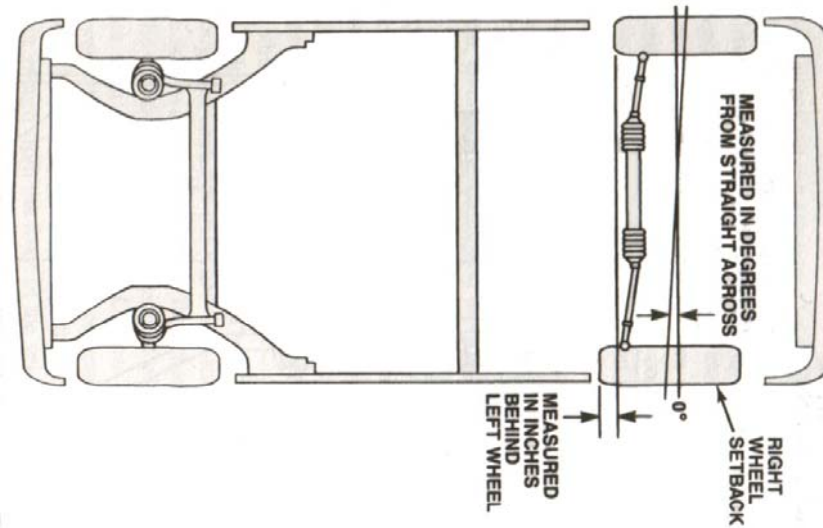




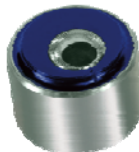
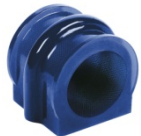
## Understanding Steering & Wheel Alignment Angles

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Set Back Is The Variation In Wheel Base Of The Vehicle



- Measured By Modern Wheel Alignment Machines
- Set Back Changes With Caster Change
- Excessive Set Back Can Cause The Vehicle To 'Run Off'

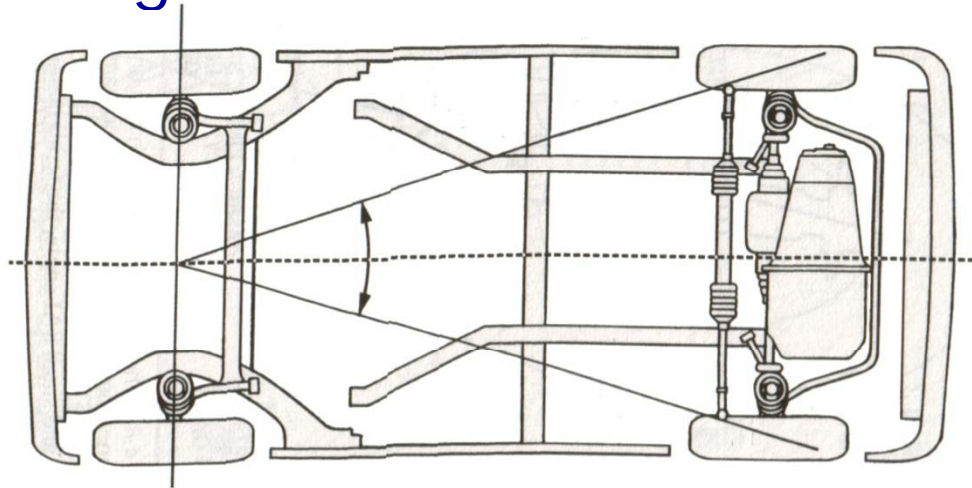




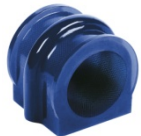
## Understanding Steering & Wheel Alignment Angles

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### Ackerman Angle Provides Correct Toe Out On Turns



- Line Drawn Though:-
  - Centre Of Footprint
  - Tie Rod Attaching Point On Steering Arm
  - Meet In Centre Of Line Drawn Through Rear Axle
  - Angle Of Turn Of Front Wheels Will Be Correct

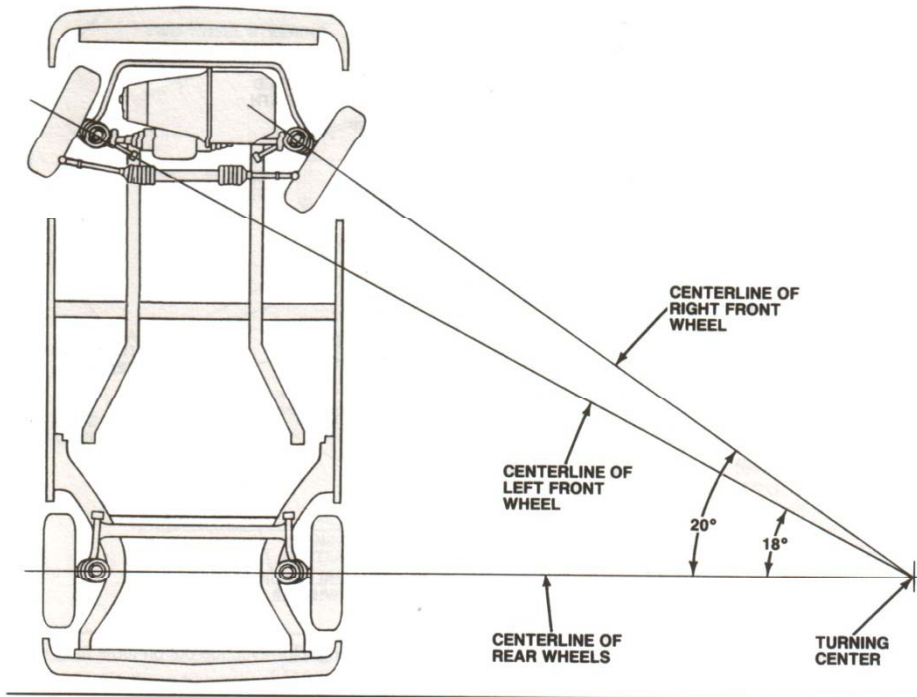




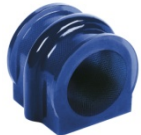
# Understanding Steering & Wheel Alignment Angles

[www.SuperPro.com.au](http://www.SuperPro.com.au)

## Ackerman Effect In Corners



- Inside Wheel In turn Requires Greater Angle Of Turn
- Outside Wheel Requires Less Turning Angle
- Lines Projected Will Meet At Intersection Point Outside Vehicle

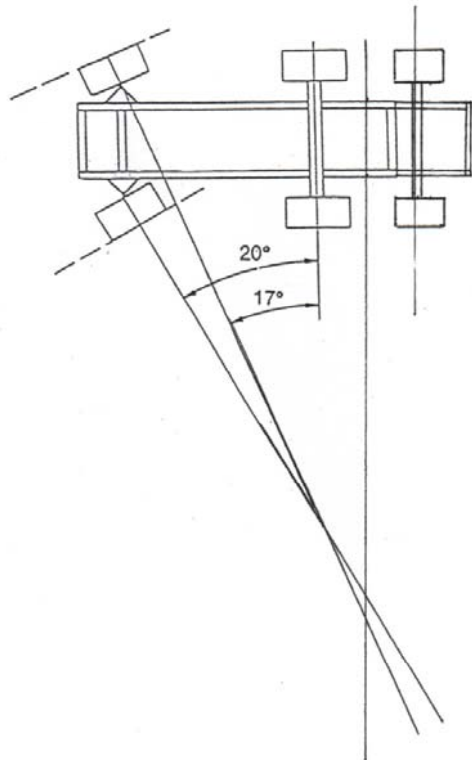




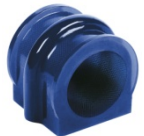
## Understanding Steering & Wheel Alignment Angles

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Effect On Ackerman Angle When Wheel Base Increased Or Extra Axle Added



- Line Now Drawn Midway Between Rear Axles
- Intersection Points Changed
- Front Turn Angle Not Correct
- Tyres Will Scrub and Squeal





## Understanding Steering & Wheel Alignment Angles

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# Bump Steer

Variation in Toe That Occurs As The Front Suspension Moves Up and Down Without Body Roll and Caused By:-

- Incorrect Steering Linkage Design Or Tie Rod Location
- Bent Steering Linkage
- Toe Adjusted Without Centralising Steering Gear
- Soft Suspension Bushes and Worn Components
- Misalignment of Rack or Steering Linkage in Frame





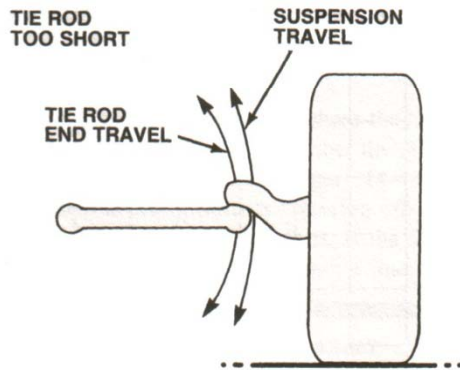


# Understanding Steering & Wheel Alignment Angles

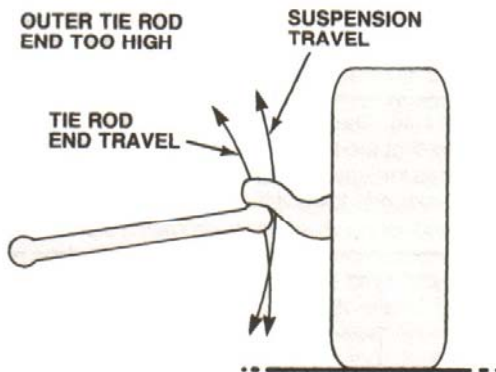
[www.SuperPro.com.au](http://www.SuperPro.com.au)

## Incorrect Attachment Of Tie Rod End

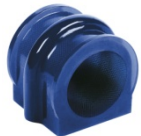
### TOE CHANGE



- Change in Toe With Rod End Too Short



- Bump Steer With Tie Rod Mounted Too High



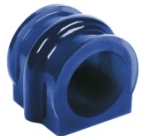
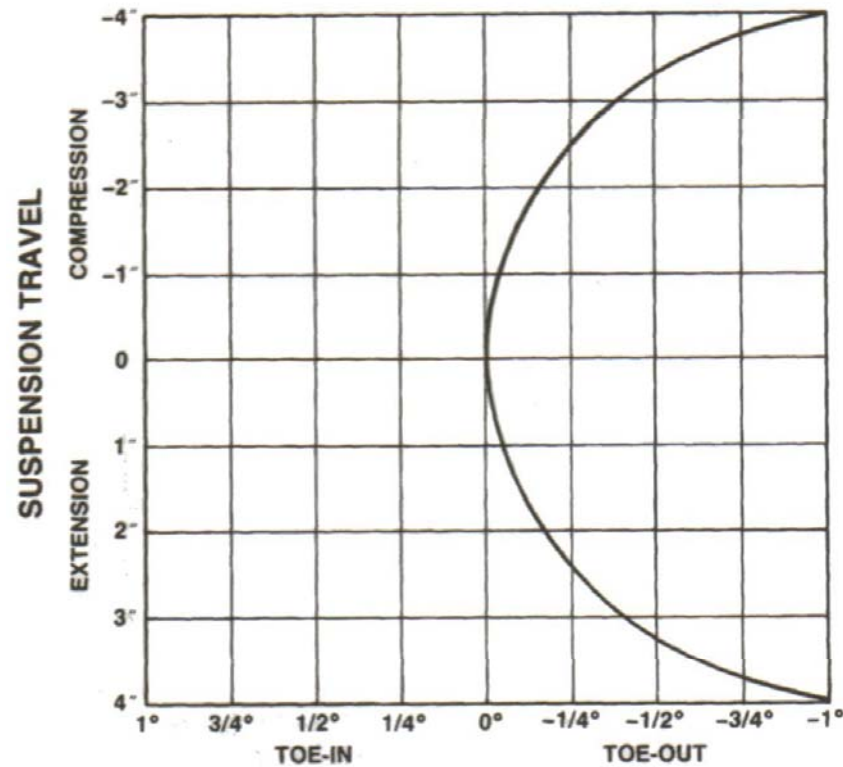




## Understanding Steering & Wheel Alignment Angles

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Graph Represents Toe change With Tie Rod Too Short

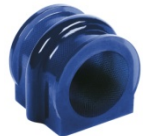
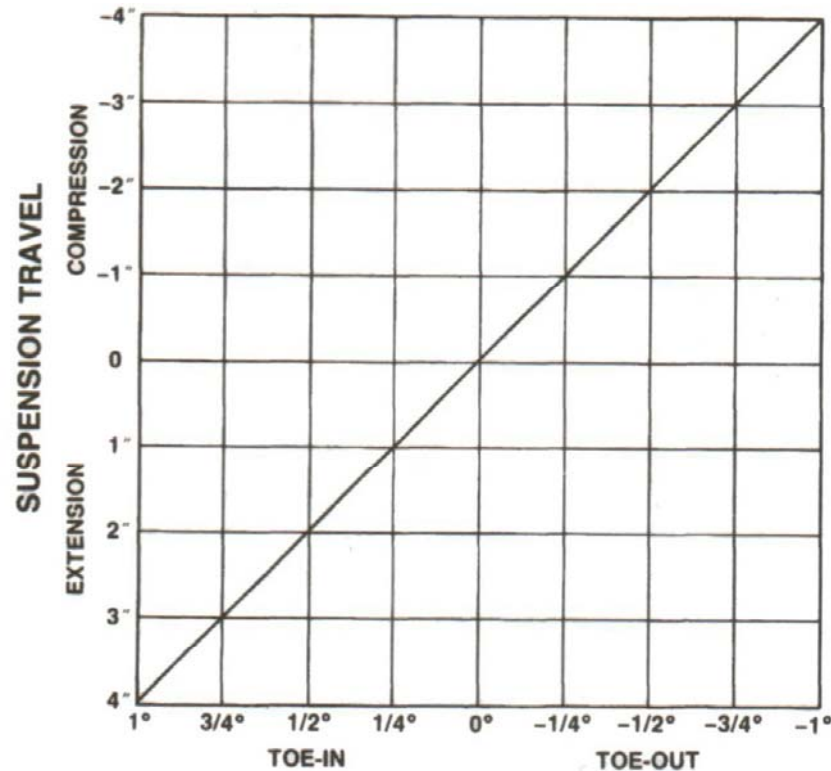




## Understanding Steering & Wheel Alignment Angles

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Graph Represents Toe Change Caused By Outer Tie Rod Being Higher Than Inner Tie Rod



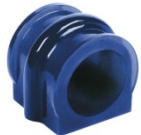
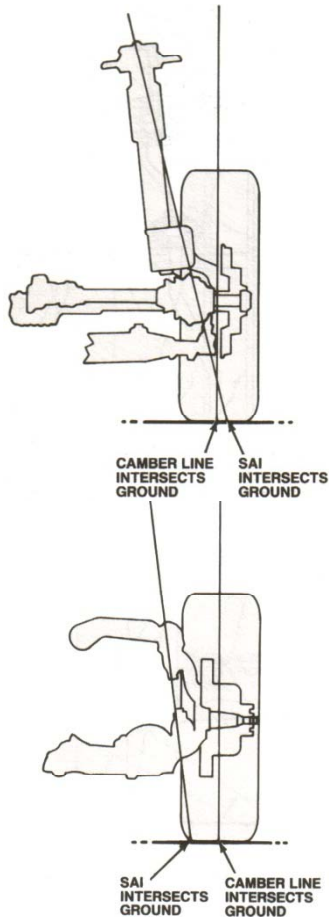


## Understanding Steering & Wheel Alignment Angles

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### Positive and Negative Scrub Radius

- Positive Scrub Radius Lines Meet Below Road Surface
- Usually Rear Wheel Drive With Front Wheel Toe In
- S.A.I. Usually Less Than 10 Degrees
- Negative Scrub Radius Lines Meet Above Road Surface
- Used On Front Wheel Drive With Front Wheel Toe Out Or Zero Toe
  - S.A.I. Usually Greater Than 10 Degrees

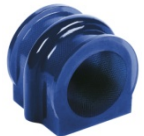
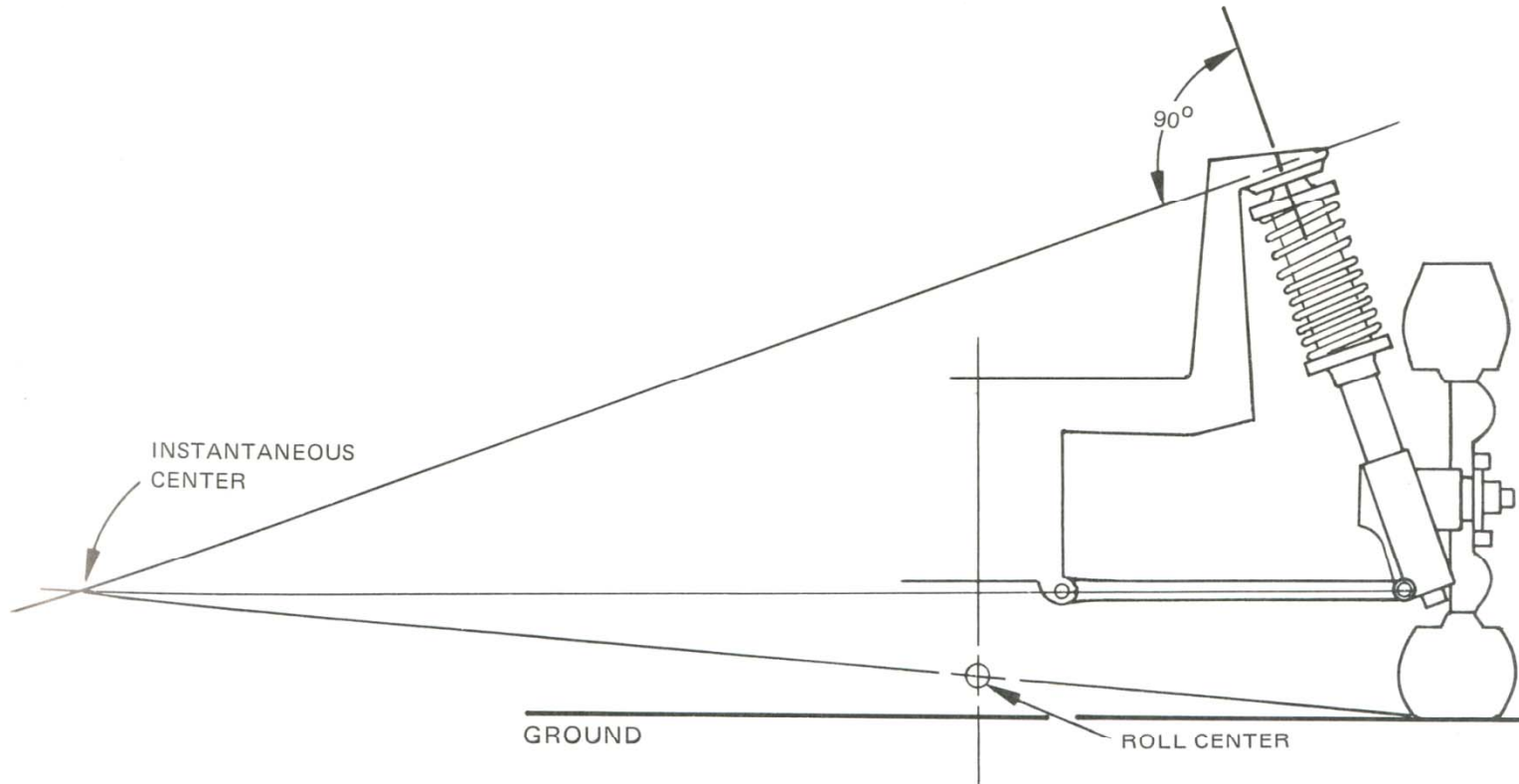




# Understanding Steering & Wheel Alignment Angles

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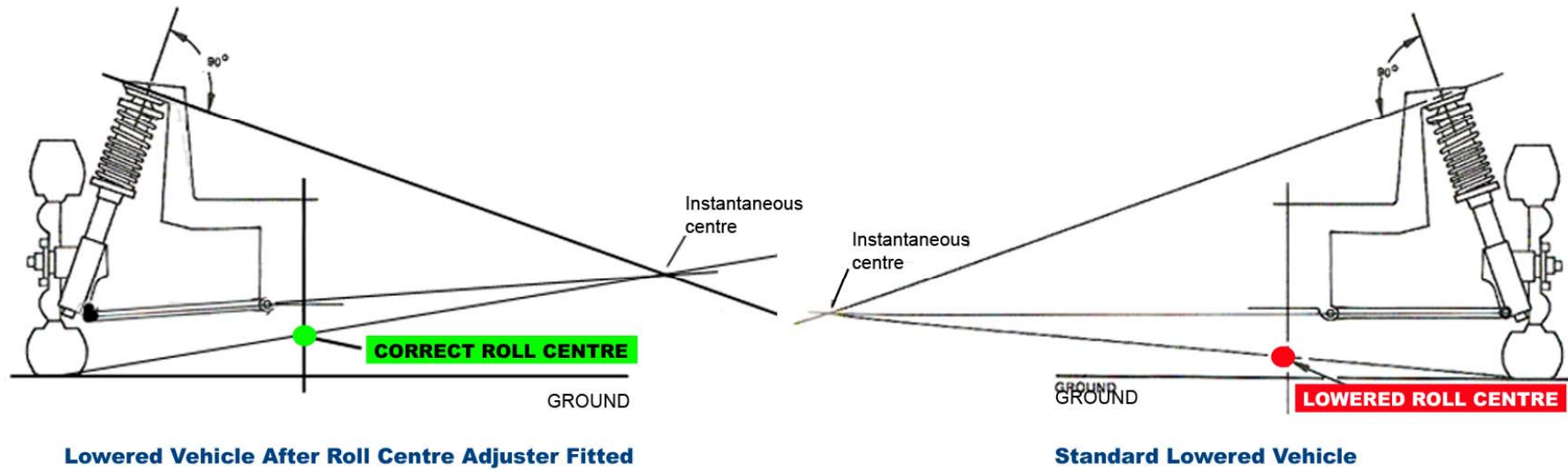
## Calculating the Roll Centre





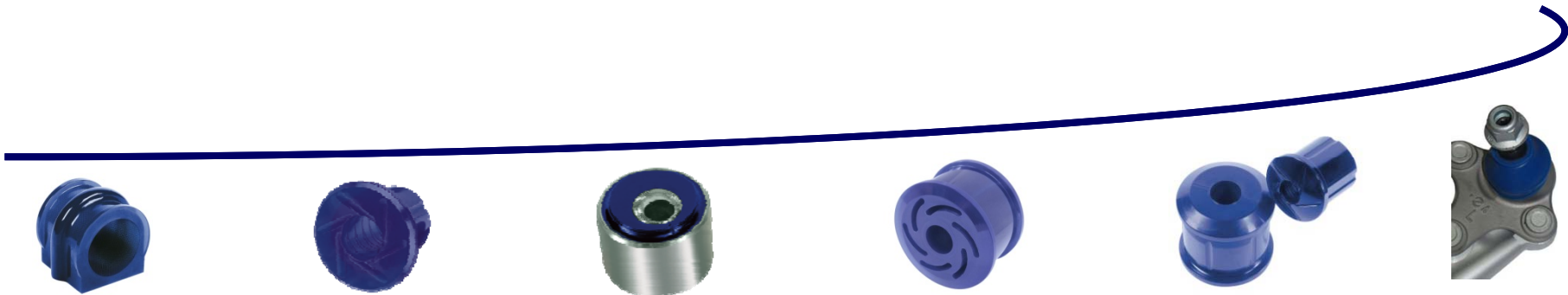
# Understanding Steering & Wheel Alignment Angles

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Lowered Vehicle After Roll Centre Adjuster Fitted

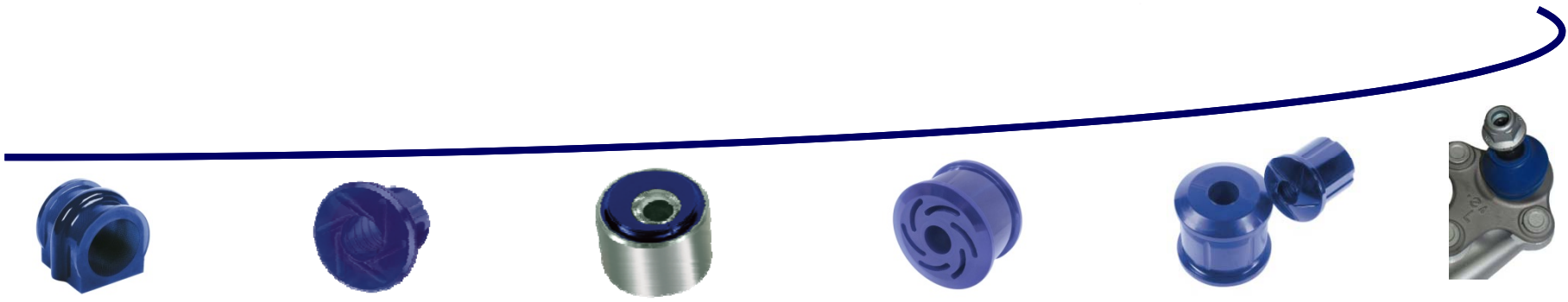
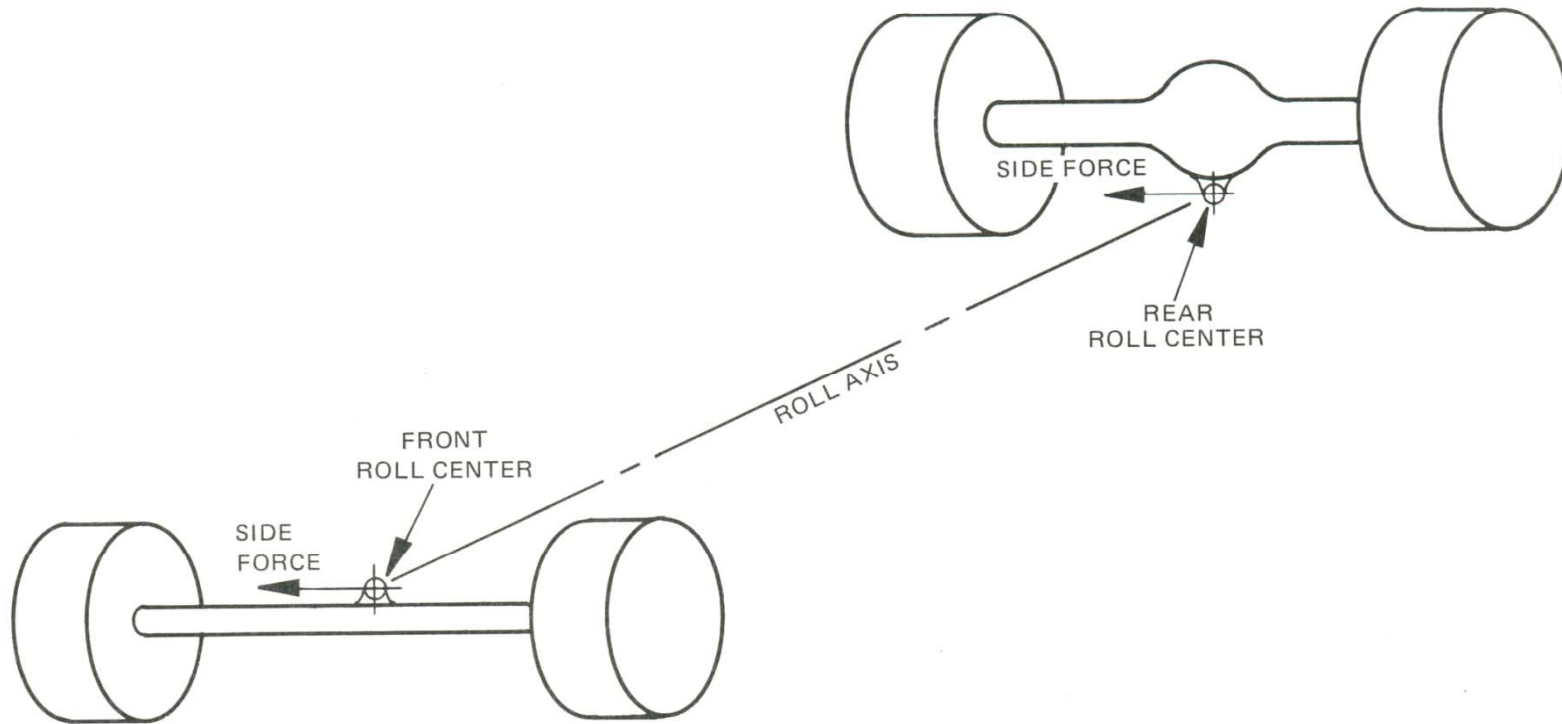
Standard Lowered Vehicle





# Understanding Steering & Wheel Alignment Angles

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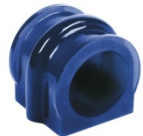
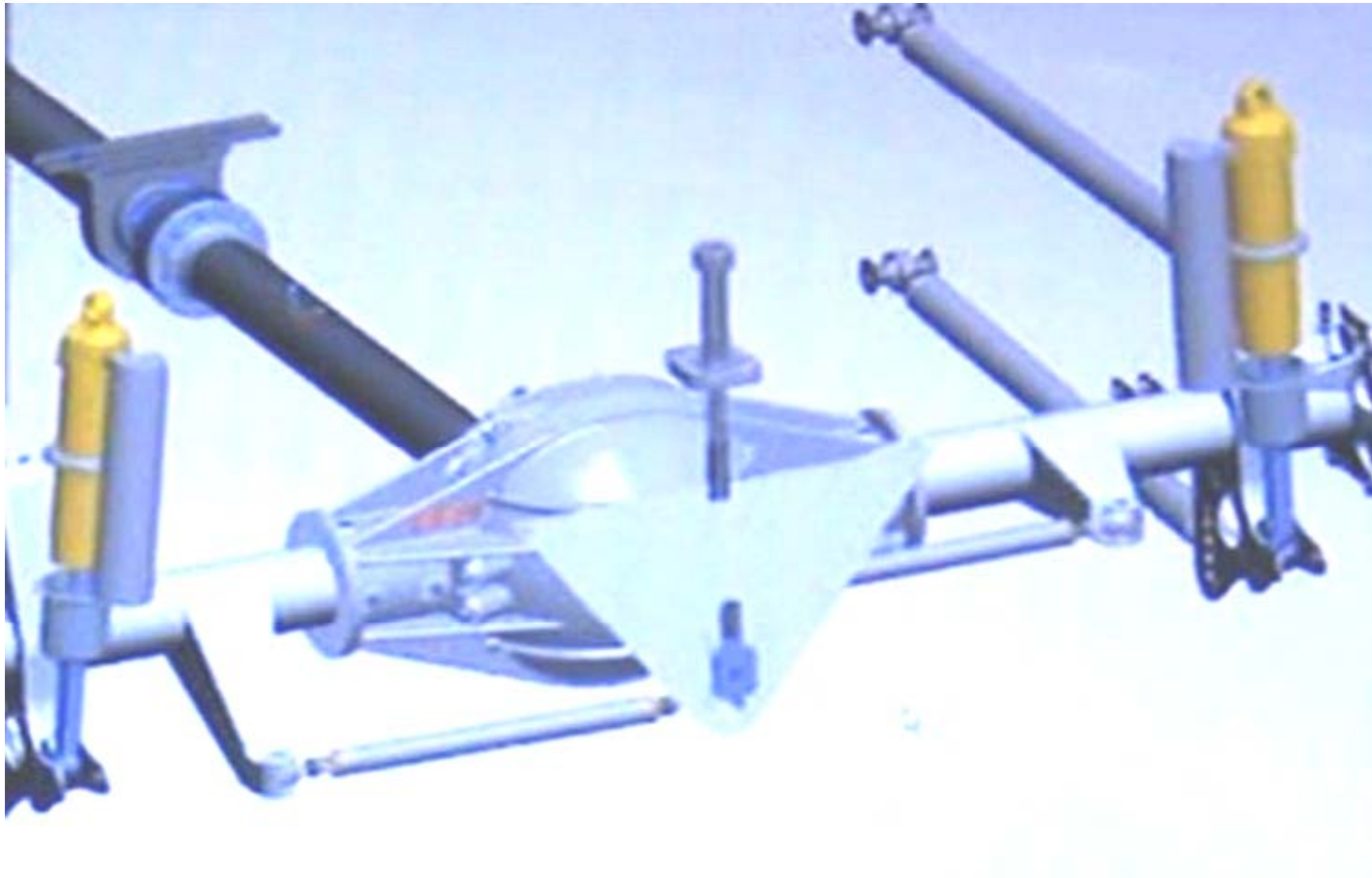






# Understanding Steering & Wheel Alignment Angles

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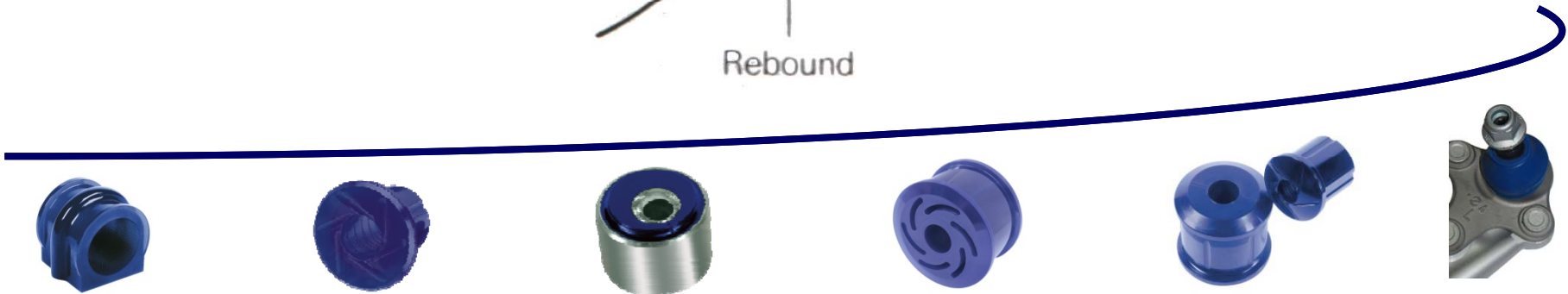
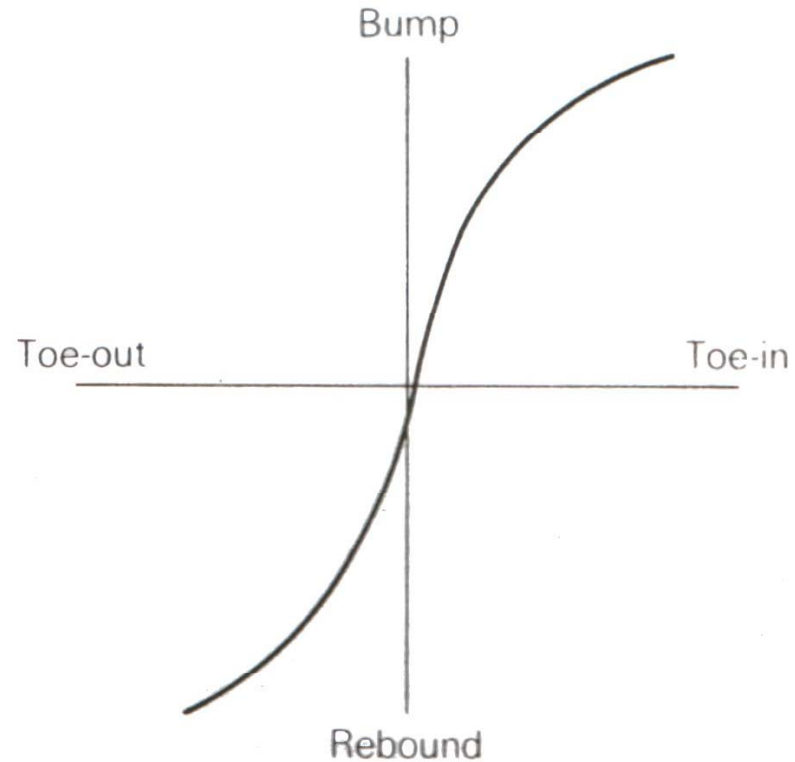




## Understanding Steering & Wheel Alignment Angles

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### Rear Toe Steer Through Bump and Rebound

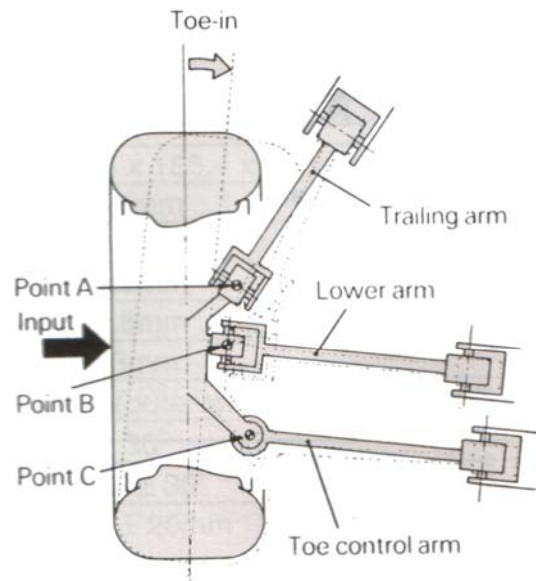




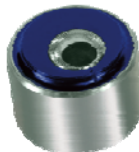
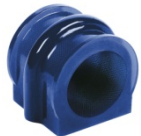
## Understanding Steering & Wheel Alignment Angles

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### Variation In Rear Toe With Axial Thrust – Importance of good suspension and bushing compliance control



- Axial Force At 'A' Moves Arm Obliquely
- Bushes at Point 'C' are Compressed
- Point 'B' Is Displaced Towards Center Of Vehicle

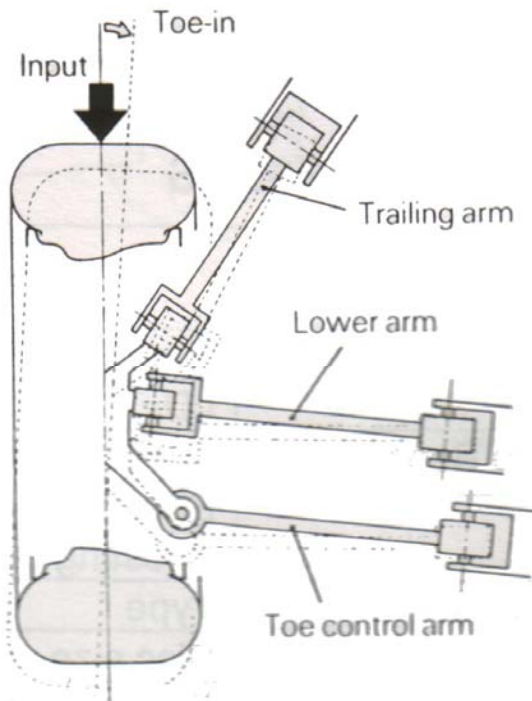




## Understanding Steering & Wheel Alignment Angles

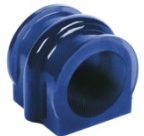
[www.SuperPro.com.au](http://www.SuperPro.com.au)

### Variation In Rear Toe With Longitudinal Input – Importance of good suspension and bushing compliance control



- Compliance Steer Generated By Road Surface Or Braking

- Toe-In State Maintained By Action Of Arms





For Additional Information including solutions for better suspension and bushing compliance control contact SuperPro or connect to

[www.SuperPro.com.au](http://www.SuperPro.com.au)

