WHEEL ALLIGNMENT

MODULE

AUTOMOTIVE TECHNOLOGY CENTRE (ATeC)
CENTER OF TECHNOLOGY PSMZA

POLITEKNIK MALAYSIA
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MODUL WHEEL ALLIGNMENT ini merupakan satu modul pembelajaran yang diolah untuk tujuan bahan kursus pembelajaran sepanjang hayat di bawah Automotive Technology Center, Politeknik Sultan Mizan Zainal Abidin. Modul ini merangkumi teori berkenaan tayar, system suspense, penjajaran roda dan juga pemeriksaan. Di dalam modul ini, terdapat penerangan berkaitan prosedur-prosedur yang perlu dilakukan sebelum melakukan penjajaran roda merangkumi pmeriksaan system suspense dan juga pemeriksaan tayar. Dalam bahagian praktikal pula merangkumi arahan kerja bagi melakukan penjajaran roda termasuklah penggunaan mesin penjajaran, membaca bacaan penjajaran, pelarasan toe, pelarasan camber dan juga bacaan caster.

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PREFACE

In the name of Allah, The most Gracious and Merciful. All praise to Allah S.W.T for His great loving kindness and blessing, this book is successfully published.

This book is designed to explain more detail on theory on tires, suspense systems, wheel alignment and inspections. In this module, there is a description of the procedures that need to be done before the wheel alignment, including the inspection of the suspense system and the inspection of the tires. In the practical part, it includes work instructions for wheel alignment, including the use of an alignment machine, reading alignment readings, toe adjustment, camber adjustment and caster readings

The authors would like to express deepest appreciation to all those who provided the possibility in publishing this book especially friends and colleagues. Many thanks also go to the Mechanical Engineering Department administration team for the support and guidance throughout the process of completing this book. Thank You.

CONTENT

THEORY

SUSPENSION SYSTEM

The modern automobile has come along way since the days when "just being self propelled" was enough to satisfy the car owner. Improvement in suspension, increased strength & durability of components, and advances in tire design and construction has made large contributions to tiding comfort and driving safety.

Basically, suspension refers to the use of front and rear springs to suspend a vehicles frame, body, engine and power train above the wheels. These relatively heavy assemblies constitute what is known as Sprung weight.

Unsprung weight, on the other hand, includes wheels and tire, break assemblies and other structural members not supported by the springs.

The springs used in today's cars and trucks are engineered in a wide variety of types, shapes, sizes, rates and capacities. Types include:

- leaf springs
- coil springs
- air springs and torsion bars.
- Independent Suspension System

These are used in sets of four per vehicle, or they are paired off in various combinations and are attached to the vehicle by a number of different mounting techniques.

The automobile frame and body are mounted on the front and rear axle not directly but through the springs and shock absorbent. The assembly of parts, which perform the isolation of parts from the road shocks, may be in the forms of bounce, pitch and roll is called suspension system.

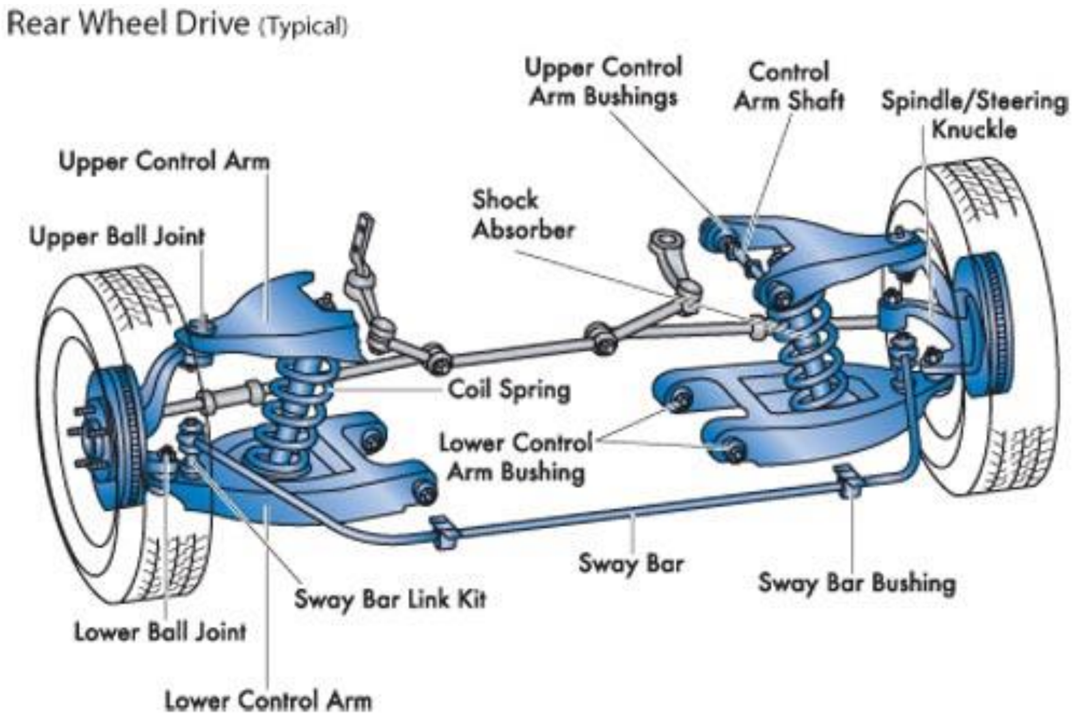


FIGURE 1: Suspension System

Suspension system of an automobile separates the wheel and axle assembly of the automobile from its body. Main function of the suspension system is to isolate the body of the vehicle from shocks and vibrations generated due to irregularities on the surface of roads. Shock absorbers are provided in the vehicles for this purpose. It is in the form of spring and damper. The suspension system is provided both on front end and rear end of the vehicle.

A suspension system also maintains the stability of the vehicle in pitching or rolling when vehicle is in motion.

Functions of suspension system:

- It prevents the vehicle body and frame from road shocks.
- It gives stability of the vehicle.
- It safeguards the passengers and goods from road shocks.
- It gives the good road holding while driving, cornering and braking.
- It gives cushioning effect.
- It provides comfort.

Requirements of suspension system:

- There should be minimum deflection.
- It should be of low initial cost.
- It should be of minimum weight.
- It should have low maintenance and low operating cost.
- It should have minimum tyre wear.

Components of Suspension system:

- Coil springs
- Leaf springs
- shock absorbers
- Spring shackles

- stabilizer

TYRE

A tire (American English) or tyre (British English) is a ring-shaped component that surrounds a wheel's rim to transfer a vehicle's load from the axle through the wheel to the ground and to provide traction on the surface over which the wheel travels. Most tires, such as those for automobiles and bicycles, are pneumatically inflated structures, which also provide a flexible cushion that absorbs shock as the tire rolls over rough features on the surface. Tires provide a footprint, called a contact patch, that is designed to match the weight of the vehicle with the bearing strength of the surface that it rolls over by providing a bearing pressure that will not deform the surface excessively.

The materials of modern pneumatic tires are synthetic rubber, natural rubber, fabric and wire, along with carbon black and other chemical compounds. They consist of a tread and a body. The tread provides traction while the body provides containment for a quantity of compressed air. Before rubber was developed, the first versions of tires were simply bands of metal fitted around wooden wheels to prevent wear and tear. Early rubber tires were solid (not pneumatic). Pneumatic tires are used on many types of vehicles, including cars, bicycles, motorcycles, buses, trucks, heavy equipment, and aircraft. Metal tires are still used on locomotives and railcars, and solid rubber (or other polymer) tires are still used in various non-automotive applications, such as some casters, carts, lawnmowers, and wheelbarrows.

HISTORY OF TYRE

The earliest tires were bands of leather, then iron (later steel) placed on wooden wheels used on carts and wagons. A skilled worker, known as a wheelwright, would cause the tire to expand by heating it in a forge fire, place it over the wheel and quench it, causing the metal to contract back to its original size so that it would fit tightly on the wheel.

The first patent for what appears to be a standard pneumatic tire appeared in 1847 lodged by Scottish inventor Robert William Thomson. However, this never went into production. The first practical pneumatic tire was made in 1888 on May Street, Belfast, by Scots-born John Boyd Dunlop, owner of one of Ireland's most prosperous veterinary practices.

It was an effort to prevent the headaches of his 10-year-old son Johnnie, while riding his tricycle on rough pavements. His doctor, John, later Sir John Fagan, had prescribed cycling as an exercise for the boy, and was a regular visitor. Fagan participated in designing the first pneumatic tires.

Cyclist Willie Hume demonstrated the supremacy of Dunlop's tires in 1889, winning the tire's first-ever races in Ireland and then England.[8][9] In Dunlop's tire patent specification dated 31 October 1888, his interest is only in its use in cycles and light vehicles. In September 1890, he was made aware of an earlier development but the company kept the information to itself.

In 1892, Dunlop's patent was declared invalid because of prior art by forgotten fellow Scot Robert William Thomson of London (patents London 1845, France 1846, USA 1847), although Dunlop is credited with "realizing rubber could withstand the wear and tear of being a tire while retaining its resilience".

John Boyd Dunlop and Harvey du Cros together worked through the ensuing considerable difficulties. They employed inventor Charles Kingston Welch and also acquired other rights and patents which allowed them some limited protection of their Pneumatic Tyre business's position. Pneumatic

Tyre would become Dunlop Rubber and Dunlop Tyres. The development of this technology hinged on myriad engineering advances, including the vulcanization of natural rubber using sulfur, as well as by the development of the "clincher" rim for holding the tire in place laterally on the wheel rim.

Synthetic rubbers were invented in the laboratories of Bayer in the 1920s. Rubber shortages in the United Kingdom during WWII prompted research on alternatives to rubber tires with suggestions including leather, compressed asbestos, rayon, felt, bristles and paper.

In 1946, Michelin developed the radial tire method of construction. Michelin had bought the bankrupt Citroën automobile company in 1934, so it was able to fit this new technology immediately. Because of its superiority in handling and fuel economy, use of this technology quickly spread throughout Europe and Asia.

In the US, the outdated bias-ply tire construction persisted, until the Ford Motor Company adopted radial tires in the early 1970s following a 1968 article in an influential American magazine, Consumer Reports, highlighting the superiority of radial construction. The US tire industry lost its market share to Japanese and European manufacturers, which bought out US companies.

TYPE OF TYRE

High-performance rally tires

Light-duty tires for passenger vehicles carry loads in the range of 550 to 1,100 pounds (250 to 500 kg) on the drive wheel. Light-to-medium duty trucks and vans carry loads in the range of 1,100 to 3,300 pounds (500 to 1,500 kg) on the drive wheel. They are differentiated by speed rating for different vehicles, including (starting from the lowest speed to the highest): winter tires, light truck tires, entry-level car tires, sedans and vans, sport sedans, and high-performance cars. Apart from road tires, there are special categories:

Snow tires are designed for use on snow and ice. They have a tread design with larger gaps than those on summer tires, increasing traction on snow and ice. Such tires that have passed a specific winter traction performance test are entitled to display a "Three-Peak Mountain Snow Flake" symbol on their sidewalls. Tires designed for winter conditions are optimized to drive at temperatures below 7 °C (45 °F).

Some snow tires have metal or ceramic studs that protrude from the tire to increase traction on hard-packed snow or ice. Studs abrade dry pavement, causing dust and creating wear in the wheel path. Regulations that require the use of snow tires or permit the use of studs vary by country in Asia and Europe, and by state or province in North America.

All-season tires are typically rated for mud and snow (M+S). These tires have tread gaps that are smaller than snow tires and larger than conventional tires. They are quieter than snow tires on clear roads, but less capable on snow or ice.

All-terrain tires are designed to have adequate traction off-road, yet have benign handling and noise characteristics for highway driving.[26] Such tires are rated better on snow and rain than street tires and "good" on ice, rock and sand.

Mud-terrain tires have a deeper, more open tread for good grip in mud, than all-terrain tires, but perform less well on pavement.[28]

High-performance tires are rated for speeds up to 168 miles per hour (270 km/h) and ultra-high-performance tires are rated for speeds up to 186 miles per hour (299 km/h), but have harsher ride characteristics and durability.[29] Other types of light-duty automotive tires include run-flat tires and race car tires:

Run-flat tires obviate the need for a spare tire, because they can be travelled on at a reduced speed in the event of a puncture, using a stiff sidewall to prevent damage to the tire rim. Vehicles without run-flat tires rely on a spare tire, which may be a compact tire, to replace a damaged tire.

Race car tires come in three main categories, DOT (street-legal), slick, and rain. Race car tires are designed to maximize cornering and acceleration friction at the expense of longevity. Racing slicks have no tread to maximize contact with the pavement and rain tires have channels to eject water to avoid hydroplaning.

Heavy duty

Off-road tires under transport

Heavy duty tires for large trucks and buses come in a variety of profiles and carry loads in the range of 4,000 to 5,500 pounds (1,800 to 2,500 kg) on the drive wheel. These are typically mounted in tandem on the drive axle.[30]

Truck tires come in a variety of profiles that include "low profile" with a section height that is 70 to 45% of the tread width, "wide-base" for heavy vehicles, and a "super-single" tire that has the same total contact pressure as a dual-mounted tire combination.

Off-road tires are used on construction vehicles, agricultural and forestry equipment and other applications that take place on soft terrain. The category also includes machinery that travels over hardened surfaces at industrial sites, ports and airports. Tires designed for soft terrain have a deep, wide tread to provide traction in loose dirt, mud, sand, or gravel.

Tires on the wheels of a bogie

Aircraft tires are designed for landing on paved surfaces and rely on their landing gear to absorb the shock of landing. To conserve weight and space required, they are typically small in proportion to the vehicle that they support. Most are radial-ply construction. They are designed for a peak load when the aircraft is stationary, although side loads upon landing are an important factor. Although hydroplaning is a concern for aircraft tires, they typically have radial grooves and no lateral grooves or sipes. Some light aircraft employ large-diameter, low-pressure tundra tires for landing on unprepared surfaces in wilderness areas.

Bicycle tires may be designed for riding on roads or over unimproved terrain and may be mounted on vehicles with more than two wheels. There are three main types: clincher, wired and tubular. Most bicycle tires are clincher and have a bead that presses against the wheel rim. An inner tube provides the air pressure and the contact pressure between bead and wheel rim.

Industrial tires support such vehicles as forklifts, tractors, excavators, road rollers, and bucket loaders. Those used on smooth surfaces have a smooth tread, whereas those used on soft surfaces typically have large tread features Some industrial tires are solid or filled with foam.

Motorcycle tires provide traction, resisting wear, absorbing surface irregularities, and allow the motorcycle to turn via countersteering. The two tires' contact with the ground affect safety, braking, fuel economy, noise, and rider comfort.

Components

Components of a radial tire

Mountain bicycle tires with an open-lug pattern for grip in soft soil

Absence of grooves maximizes dry-pavement friction on a set of slick Formula One tires. A tire comprises several components: the tread, bead, sidewall, shoulder, and ply.

Tread

The tread is the part of the tire that comes in contact with the road surface. The portion that is in contact with the road at a given instant in time is the contact patch. The tread is a thick rubber, or rubber/composite compound formulated to provide an appropriate level of traction that does not wear away too quickly.

The tread pattern is characterized by a system of circumferential grooves, lateral sipes, and slots for road tires or a system of lugs and voids for tires designed for soft terrain or snow. Grooves run circumferentially around the tire, and are needed to channel away water. Lugs are that portion of the tread design that contacts the road surface. Grooves, sipes and slots allow tires to evacuate water.

The design of treads and the interaction of specific tire types with the roadway surface affects roadway noise, a source of noise pollution emanating from moving vehicles. These sound intensities increase with higher vehicle speeds. Tires treads may incorporate a variety of distances between slots (pitch lengths) to minimize noise levels at discrete frequencies.

Sipes are slits cut across the tire, usually perpendicular to the grooves, which allow the water from the grooves to escape sideways and mitigate hydroplaning.

Different tread designs address a variety of driving conditions. As the ratio of tire tread area to groove area increases, so does tire friction on dry pavement, as seen on Formula One tires, some of which have no grooves.

High-performance tires often have smaller void areas to provide more rubber in contact with the road for higher traction, but may be compounded with softer rubber that provides better traction, but wears quickly. Mud and snow

(M&S) tires employ larger and deeper slots to engage mud and snow. Snow tires have still larger and deeper slots that compact snow and create shear strength within the compacted snow to improve braking and cornering performance.

Wear bars (or wear indicators) are raised features located at the bottom of the tread grooves that indicate the tire has reached its wear limit. When the tread lugs are worn to the point that the wear bars connect across the lugs, the tires are fully worn and should be taken out of service, typically at a remaining tread depth of 1.6 millimetres (0.063 in).

Other

The tire bead is the part of the tire that contacts the rim on the wheel. The bead is typically reinforced with steel wire and compounded of high strength, low flexibility rubber. The bead seats tightly against the two rims on the wheel to ensure that a tubeless tire holds air without leakage. The bead fit is tight to ensure the tire does not shift circumferentially as the wheel rotates. The width of the rim in relationship to the tire is a factor in the handling characteristics of an automobile, because the rim supports the tire's profile.

The sidewall is that part of the tire, or bicycle tire, that bridges between the tread and bead. The sidewall is largely rubber but reinforced with fabric or steel cords that provide for tensile strength and flexibility. The sidewall contains air pressure and transmits the torque applied by the drive axle to the tread to create traction but supports little of the weight of the vehicle, as is clear from the total collapse of the tire when punctured. Sidewalls are molded with manufacturer-specific detail, government mandated warning labels, and other consumer information, and sometimes decorative ornamentation, like whitewalls or tire lettering.

The shoulder is that part of the tire at the edge of the tread as it makes transition to the sidewall.

Plies are layers of relatively inextensible cords embedded in the rubber to hold its shape by preventing the rubber from stretching in response to the internal pressure. The orientations of the plies play a large role in the performance of the tire and is one of the main ways that tires are categorized.[63]

Materials

The materials of modern pneumatic tires can be divided into two groups, the cords that make up the ply and the elastomer which encases them.

Cords

The cords, which form the ply and bead and provide the tensile strength necessary to contain the inflation pressure, can be composed of steel, natural fibers such as cotton or silk, or synthetic fibers such as nylon or kevlar.

Elastomer

About 50% of tires use the Styrene-butadiene copolymer as a primary ingredient. The elastomer, which forms the tread and encases the cords to protect them from abrasion and hold them in place, is a key component of pneumatic tire design. It can be composed of various composites of rubber material – the most common being styrene-butadiene copolymer – with other chemical compound such as silica and carbon black.

Optimizing rolling resistance in the elastomer material is a key challenge for reducing fuel consumption in the transportation sector. It is estimated that passenger vehicles consume approximately 5~15% of its fuel to overcome rolling resistance, while the estimate is understood to be higher for heavy trucks. However, there is a trade-off between rolling resistance and wet traction and grip: while low rolling resistance can be achieved by reducing the viscoelastic properties of the rubber compound it comes at the cost of wet traction and grip, which requires hysteresis and energy dissipation (high tangent A low tangent (δ) value at 60 °C is used as an indicator of low rolling resistance, while a high tangent (δ) value at 0 °C is used as an indicator of high wet traction. Designing an elastomer material that can achieve both high wet traction and low rolling resistance is key in achieving safety and fuel efficiency in the transportation sector.

The most common elastomer material used today is a styrene-butadiene copolymer. It combines the properties of polybutadiene, which is a highly rubbery polymer (Tg = -100 °C) having high hysteresis and thus offering good wet grip properties, with the properties of polystyrene, which is a glassy polymer (Tg = 100 °C) having low hysteresis and thus offering low rolling resistance in addition to wear resistance. Therefore, the ratio the two monomers in the styrene-butadiene copolymer is considered key in determining the glass transition temperature of the material, which is correlated to its grip and resistance properties.

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.

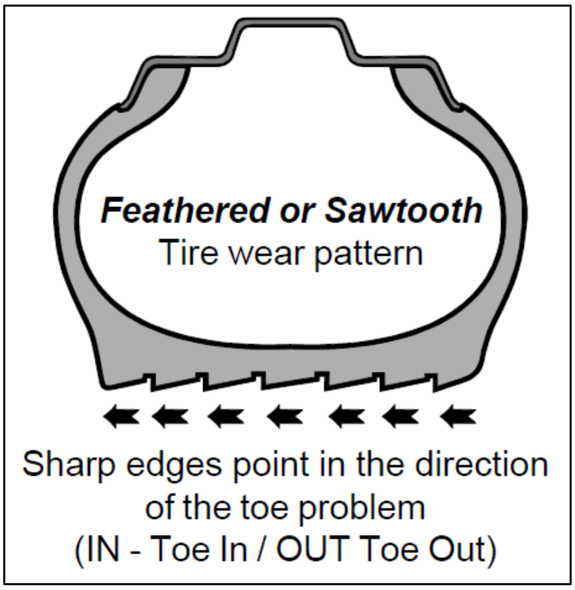


Figure 2: Feathered Wear

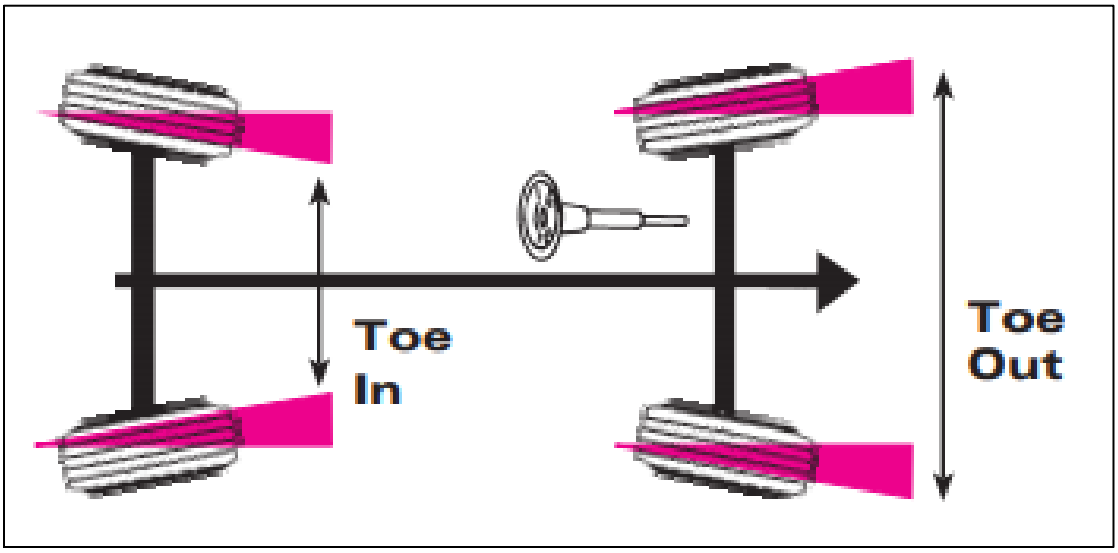


Figure 3: Toe illustration

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 sus-pension components wear from vehicle mileage, additional toe will be needed to compensate for the wear. Always correct the toe dimension last.

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.

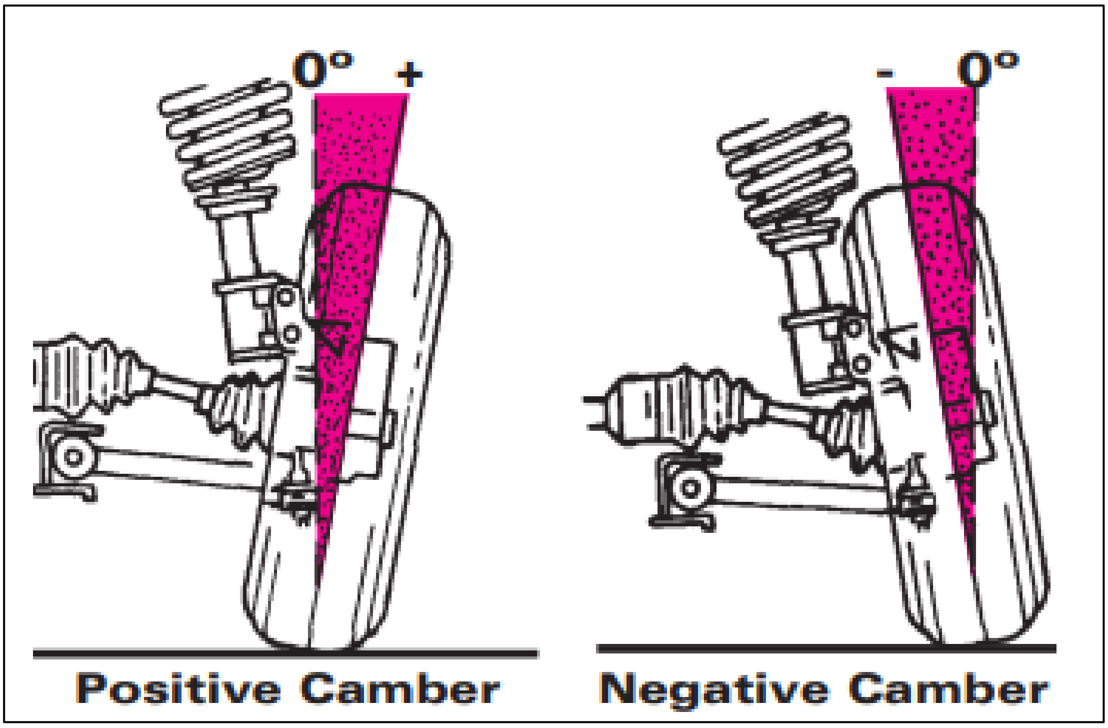


Figure 4: Camber Illustration

Camber in-fluences 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.

Figure 4: Camber Classification

A proper camber setting is necessary for several reasons:

i. It maximizes the amount of tread in constant contact with the road surface.
ii. It helps to establish the proper load point on the suspension.
iii. If incorrect, it can cause a pull or lead in the car.
iv. It is used, with another angle, to diagnose bent suspension components.

TIRE WEAR DIAGNOSIS

Because of the rigorous routine the front suspension must endure, the front tires have to work much harder than the rear tires. Even when the suspension is in good condition and the alignment is set correctly, the front tires will wear faster than the rear tires in most cases.

When an abnormal condition develops in the suspension system, it will usually affect the tires and ride. When this happens, one or even both tires can be affected and begin a wear pattern characteristic of the problem.

If a vehicle has a suspension malfunction, the wear pattern of the tire should readily show what the problem is. Typically, where multiple malfunctions have existed for many miles, attempting to get an accurate diagnosis can be difficult or impossible.

Tire Wear On One Side

When tire is wearing on one side, it can be assumed that the worn area is where road contact is being made.

Tire wear on one side only is due to inaccurate wheel camber alignment. . Incorrect camber adjustment can result from worn chassis parts, (springs, steering linkage, bushings, ball joints, etc.) or previous misalignment. Excessive negative camber effect will cause tire wear on the inside, while excessive positive camber effect will cause wear on the outside of the wheel. Sometimes, incorrect toe adjustment will cause shoulder wear on one side.

Figure 5: Tyre Wear On One Side

Feather Edging

Feather edging occur when the toe adjustment is incorrect. Miss adjustment of toe can effected from defective chassis parts, incorrect turning radius or misalignment.

Feather edging can be diagnose by sliding the hand across the tire tread surface and sharp edges will be felt in one direction and smoothness will be felt in the opposite direction. Feather edging can result in a direction pull and eventually ruin the tires. To correct the condition, alignment and tire rotation or replacement is necessary.

Figure 6: Feather Edging On Tyre

Cupping Appearance

Tires will have a "cupping" when the vehicle suspension loses its ability to absorb "jounce travel." "Jounce travel" is the upward movement of the tire in relation to the vehicle's downward movement. This condition most commonly occurs with weak shock absorbers or incorrect shock application.

Figure 7: Effect of weak suspension on tyre

Shoulder Wear (Both Sides)

When a tire is under inflated, the sidewall and contact surface will be forced to fluctuate excessively. Initially, the contact surface will buckle and the tire will travel on the edges. The immediate result is shoulder wear because the outer treads are receiving all road contact. The amount of under inflation will determine the amount and severity of the tire wear.

Consideration should also be given as to whether the tire should be dismounted for inner sidewall damage inspection. This can result from excessive heat buildup due to the added load displacement stress on the sidewalls. Check tires for slow leakage and repair as necessary.

Figure 8: Effect of incorrect tyre pressure on tyre wear

Center Wear

If tire shows signs of wear in the center of the tire tread, it likely been over inflated. Excessive pressure causes the tire to bulge in the center and will usually provide a noticeably stiff or hard ride.

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.

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. Usually the tread wear indicator are 1.6 mm thickness, follow the guidelines produce by SAE.

Figure 9: Thread wear indicator

ALIGNMENT TROUBLESHOOTING

Table 1: Trouble shooting of alignment problems

Condition	Possible Cause
Camber Not Adjustable	• Control arm bent. • Frame bent. • Hub and bearings not properly seated. • Sagging springs.
Front End Shimmy	• Excessive wheel/rim runout. • Power steering reaction bracket loose. • Steering gear box (rack) mount loose. • Steering gear adjustment loose.

	• Tires out of balance. • Tires out of round. • Wheel bearings worn or loose. • Worn steering/suspension components
Hard Steering	• Ball joint tight or seized. • Bent steering knuckle or supports. • Damaged suspension components. • Front tire pressure low. • Idler arm bushing too tight. • Power steering fluid low or belt loose. • Power steering pump defective. • Steering gear out of adjustment.
Premature Tire Wear	• Bent wheel/rim. • Improper torsion bar adjustment. • Incorrect tire inflation. • Incorrect wheel alignment. • Suspension/steering system worn. • Tires out of balance. • Uneven or sagging springs. • Worn or defective shocks/struts.
Pulls To One Side	• Brakes dragging. Broken or sagging springs. • Broken torsion bar. • Control arm bushing worn. • Frame bent.

	• Idler arm bushing too tight. • Incorrect wheel alignment. Incorrect tire inflation. Mismatched tires. • Power steering valve not cantered. • Uneven sway bar links
Toe-In Not Adjustable	• Lower control arm bent. • Frame bent. • Worn or stripped tie rod end sleeves. • Wheel bearings worn or loose.
Vehicle Wandering	• Broken spring. • Defective shock/strut. • Incorrect tire inflation. • Improper vehicle height. • Incorrect wheel alignment. • Rack & Pinion or steering not positioned correctly. • Stabilizer bar missing or defective. • Worn steering components. • Worn strut rod or control arm bushings. • Worn suspension components.

PRACTICAL

APPARATUS / MATERIALS / TOOL /EQUIPMENT (either one)

- Combination Spanner Set
- Socket tool set
- Screw Driver Set
- Alignment Machine
- Magnetic Camber Gauge
- Alignment Pit / Hoist

SAFETY

Personal safety

Whenever you perform a task in the workshop you must use personal protective clothing and equipment that is appropriate for the task and which conforms to your local safety regulations and policies. Among other items, this may include:

- Work clothing - such as coveralls and steel-capped footwear
- Eye protection - such as safety glasses and face masks
- Ear protection - such as earmuffs and earplugs
- Hand protection - such as rubber gloves and barrier cream
- Respiratory equipment - such as face masks and valved respirators

Safety check

- Some wheel are very heavy get assistance to lift heavy or awkward parts like the wheel.
- Make sure that you understand and observe all legislative and personal safety procedures when carrying out the following tasks. If you are unsure of what these are, ask your supervisor.

PROCEDURES:

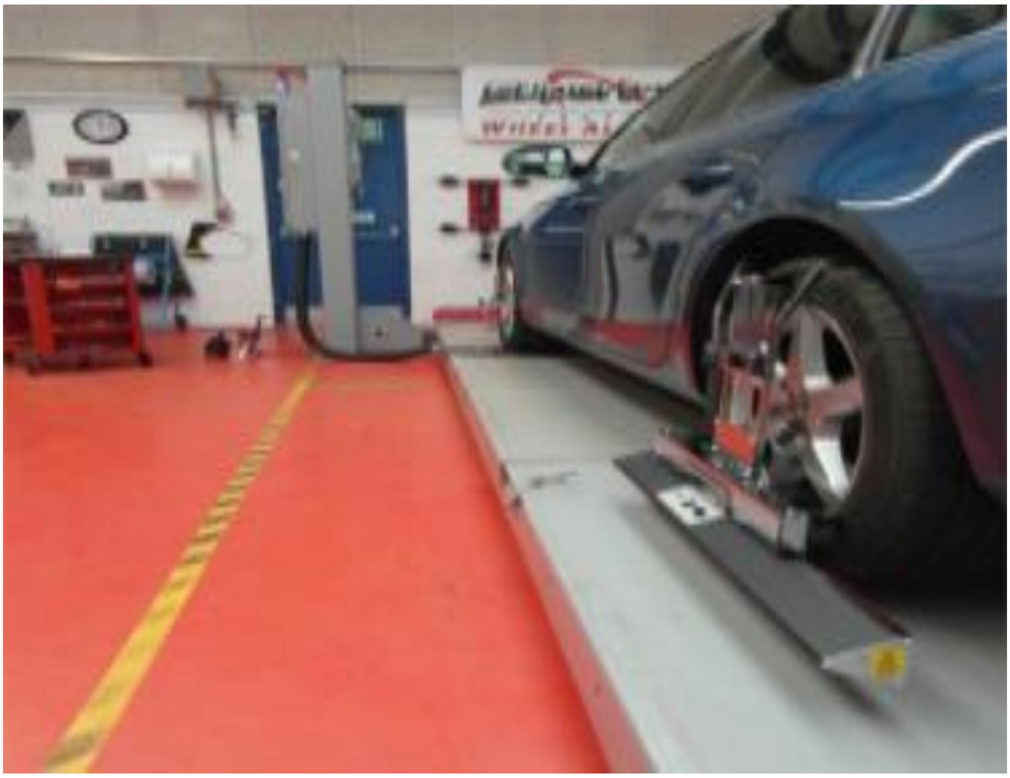
Preliminary Checks

- 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
  - Inspect the underside of the vehicle with the vehicle raised
  - Damaged parts must be repaired before adjusting alignment angles
  - Road test the vehicle – check that the steering wheel is straight

- Feel for vibration in the steering wheel and floor of seats
- Notice any pulling or handling problems, and make sure the steering wheel is centered

- Imperfections in the tires, including: tread deformations, separations, or bulges from impact damage.
  Slight sidewall indentations are normal and will not affect ride quality

Wheel Alignment



- Begin the alignment procedure by first driving the vehicle onto the alignment rack as straight as possible.

- Position the front tires in the center of the turn plates. These turn plates can be moved inward and outward to match a vehicle of any width.

- Check and adjust tire pressures and perform the pre alignment checks necessary to be assured of proper alignment.
- Select the exact vehicle on the alignment machine.
- Securely mount the alignment heads or target wheels.
- Install a brake pedal depressor to keep the front wheels from rotating when the steering wheel is turned.

Rear Wheel Alignment

Camber

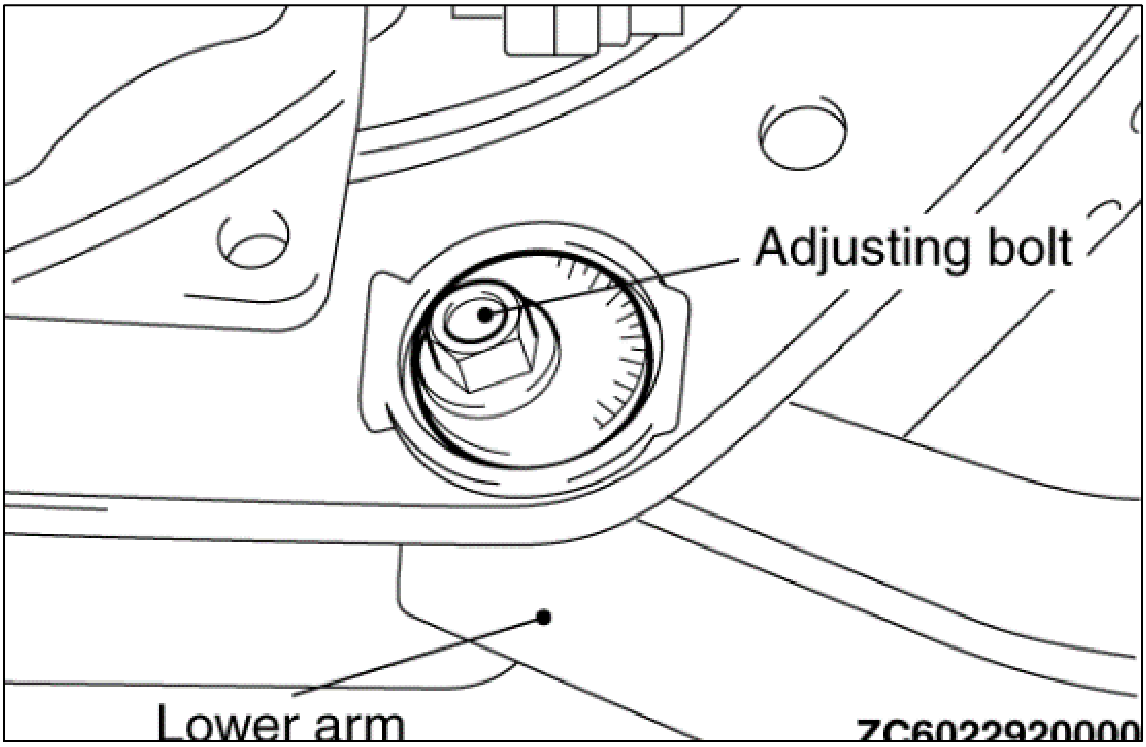


Figure 10: Adjusting bolt for rear camber

- If camber reading is not within the standard value, adjust by following procedures.
  - Adjust by turning the camber adjusting bolt of the upper arm.
  - **Left wheel: Turning clockwise (-) camber**
    Right wheel: Turning clockwise (+) camber
  - After adjusting the camber, the toe-in should be adjusted.

Toe

- If toe-in is not within the standard value, adjust as follows.
  - Be sure to adjust the camber before making toe adjustment.
  - Adjust by turning the toe adjusting bolt (toe control arm mounting bolt which faces the inside of the body).

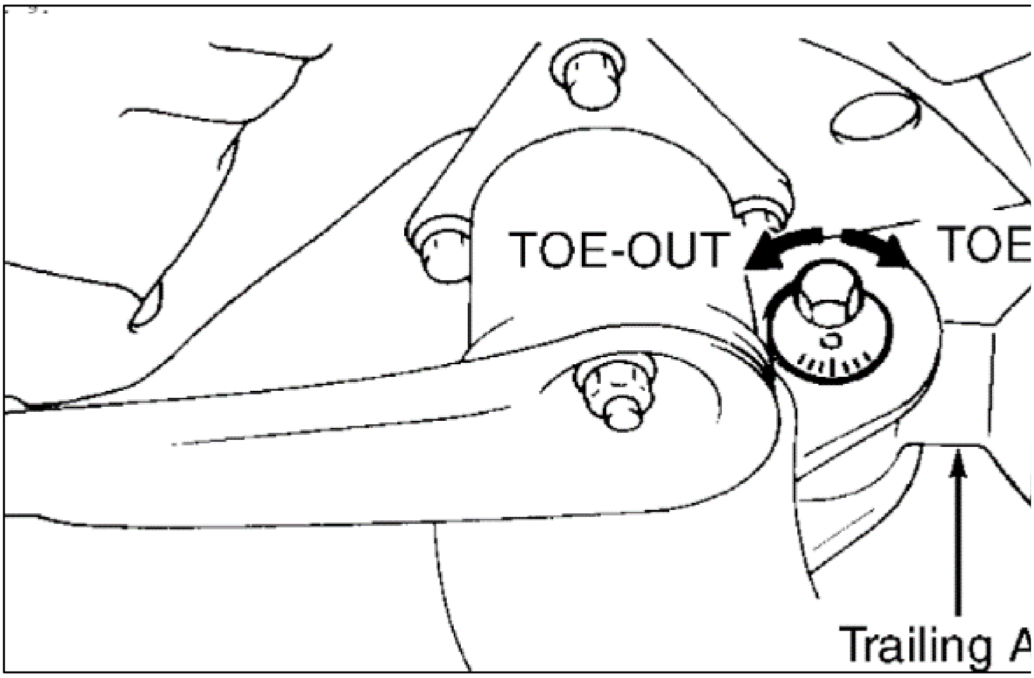


Figure 11 : Location for adjusting toe angle

Front Wheel Alignment

Camber

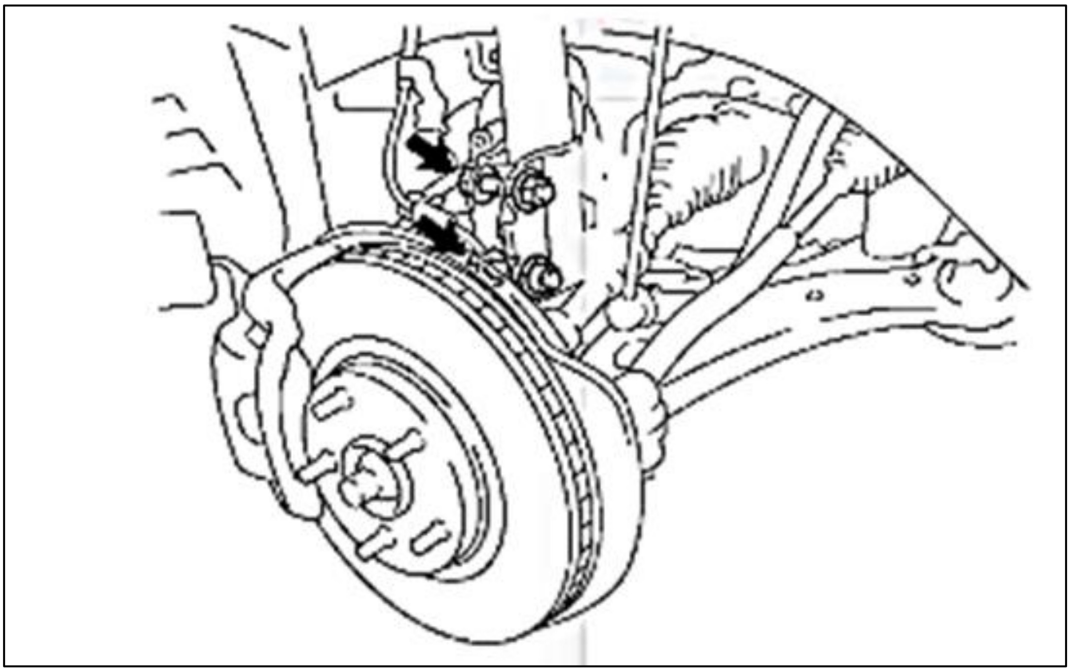


Figure 11 : Replace knuckle nut with camber bolt

- If camber reading is not within the standard value, adjust by following procedures.
  - Replace the upper knuckle nut with camber bolt.
  - Adjust by turning the camber adjusting bolt of the upper knuckle nut.
  - After adjusting the camber, the toe-in should be adjusted.

Toe

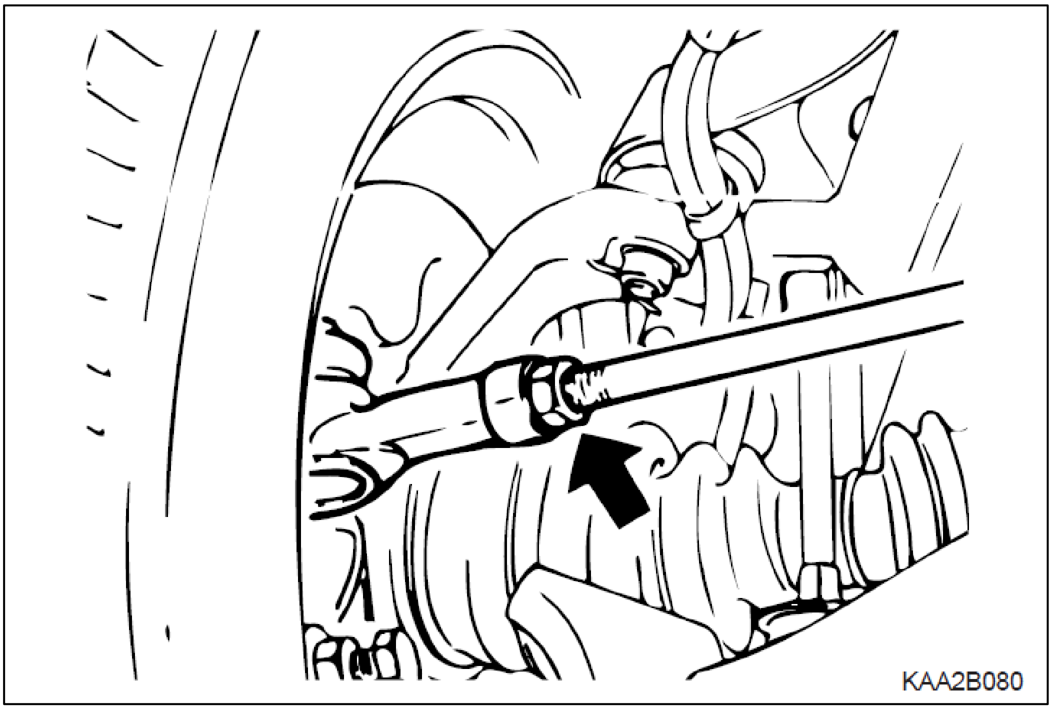


Figure 12 : Loosen the tie rod end lock nuts to adjust toe angle

- If toe reading is not within the standard value, adjust by following procedures.
  - Loosen the tie rod end lock nuts
  - Adjust by turning the tie rod till desired reading are meet
  - Tighten the lock nuts.
- After disconnecting all of the attachments, reinstalling the valve caps, and removing the steering wheel holder
- Then, the vehicle should be test driven to check for proper alignment before returning it to the customer.

RESULT / OBSERVATION:

Test Drive Result:

	OBSERVATION
Straight Line Test	
Pull Test	
Centre of Steering Wheel	
Turning Radius	
Steering Vibration / Free play	

Allignment Result:

	Reading	
	Before Adjustment	After Adjustment
Rear		
Toe		
Camber		
Front		
Toe		
Camber		

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