TRADE OF HEAVY VEHICLE MECHANIC

PHASE 2

Module 8

Steering and Suspension Systems

UNIT: 1

Road Wheel Assemblies

Table of Contents

1.0 Learning Outcome

By the end of this unit each apprentice will be able to:

- Locate and identify the major parts of various road wheel (wheel, tyre and tube) assemblies
- Explain tyre and wheel sizes/ratings
- Recognise common road wheel assembly problems
- Describe safe practices for working on road wheel assemblies
- Perform a range of maintenance tasks and procedures

1.1 Key Learning Points

- Determining roadwheel circumference using tyre data
- The advantages of rotary motion over linear motion: i.e. why it is better to move an object on rollers/wheels rather than slide it along the ground
- The rationale behind lowering the unsprung mass
- Newton's 2nd Law defined
- Inertia force calculations using Newton's 2nd Law to solve simple problems relating to momentum, force, mass and acceleration
- Statutory requirements for wheel and tyre construction
- Types of wheel (simple sketches required): steel disc, light alloy, etc
- Wheel construction (simple sketches required): hub/spider and rim, methods of connecting the hub to the rim (e.g. riveted, bolted (Trilex), spoked, or spot welded)
- Wheel rim designations (interpretation of drawings required): rim width, rim shape and rim diameter
- Wheel terminology (simple sketches required): offset, backspacing, bolt pitch circle diameter, and types of rim construction (deep-well and stepped rims)
- Wheel nuts/bolts: 'ric' clips, loosening, tightening and torqueing procedures (British Standards Code of Practice BS AU 50: Part 2: Section 7a: 1995)
- Tyre construction (simple sketches required): cross-/radial ply tyres, ply rating, tubeless tyres, thread pattern, tubeless and 'super singles'
- Tyre markings (interpretation of drawings required): section width, section height, type of tyre (cross-ply/radial), rim diameter, load index, speed rating, thread wear indicators, type approval number and running direction

- Tyre tubes and valves (simple sketches required): construction and operation
- The procedures for inflating tyres
- The rationale behind periodic tyre rotation (simple sketches required)
- The procedure for removing, rotating and refitting roadwheels
- The procedures for repairing punctures to tubed and tubeless tyres
- The correct use of compressed air, wheel cages, roadwheel trolleys, vehicle lifting equipment and safety stands
- Tyre wear patterns to determine specific roadwheel alignment defects
- The procedures for measure wheel and tyre run-out
- Static and dynamic imbalance (centrifugal and centripetal force): effects on vehicle behaviour/component service life
- The procedures and prerequisites for balancing roadwheels (on/off vehicle)
- Self-steering reactions: i.e. understeer and oversteer
- Safe methods of raising, supporting and lowering a vehicle
- Proper use and care of test equipment
- Communications with instructor/classmates during the execution of tasks
- Criteria for conducting a proper road test

2.0 Health and Safety

If the proper safety procedures are not adhered when working on **Wheels and Tyres** this could lead to serious injury / health problems to personnel.

Instruction is given in the proper safety precautions applicable to working on **Wheels and Tyres** which include the following:

- Compressed air
- Correct tyre pressure
- Danger as tyre bead locates itself on the wheel rim
- Damage to the tyre bead during refitting & removal
- Steel wire ends protruding from the crown
- Balance weights insecurely attached
- Vehicle insecurely supported
- Wheel bearings incorrectly tightened \ torque
- Road wheels not torque
- Use of Personal Protective Equipment (PPE) e.g. Eye protection, foot wear etc.

Refer to motor risk assessments, Environmental policy, and Material Safety Data Sheets (MSDS).

3.0 Wheels and Rims Explained

3.1 Wheels

Wheels must be strong enough to support the vehicle, and withstand the forces caused by normal operation. At the same time, they must be as light as possible, to help keep un-sprung weight to a minimum.

Wheels can be made from cast aluminium alloy. Alloy wheels are popular because of their appearance and because they are lighter than similar steel wheels. Aluminium is a better conductor of heat, so alloy wheels can dissipate heat from brakes and tyres more effectively than steel ones. These are often called mag or magnesium wheels, but wheels made of magnesium are rarely used on road vehicles. Most wheels have ventilation holes in the flange, so air can circulate to the brakes. Most passenger car wheels are of well, or drop-centre design. This design allows for tyre removal and fitting.

3.2 Types of Wheels

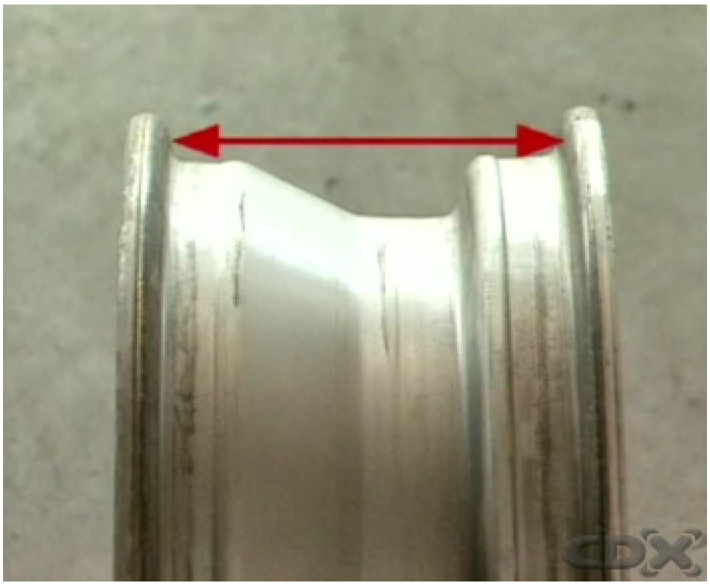
Passenger cars normally use rims which are of well based, or drop-centre design. The drop enter is used for mounting and demounting the tyre onto the rim.Wheels must be strong enough to carry the mass of the vehicle, and withstand the forces that are generated during use. The wheel centre must accurately locate the wheel rim centrally on the axle. It must also provide the required distance from the centreline of the wheel, to the face of the mounting flange.

This is called offset. Offset is important because it brings the tyre centreline into close alignment with the larger inner hub bearing, and reduces load on the stub axle. This allows the inside of the wheel centre to be shaped to provide space for the brake assembly, usually located inside the wheel. Ventilation slots allow air to circulate around the brakes. The rim must be accurately shaped, and dimensioned, and strong enough to support the tyre under the load of the vehicle and the forces generated by the motion of the vehicle.

When inflated, the tyre is locked to the rim by tapering the bead seat towards the flange, or by safety ridges or humps, close to the flange. In the event of sudden deflation, or blow-out, safety ridges prevent the tyre moving down into the well. This helps maintain control of the vehicle while it is being braked. Well-based rims can also be used on heavy commercial vehicles for tubeless tyres.

3.3 Rim Sizes & Designations

To ensure correct fit between a tyre and rim, all manufacturers of wheels and tyres comply with standard dimensions, as recommended by automotive manufactures. The width of the rim is the distance across the rim flanges, at the bead seat. Its diameter is the distance across the centre of the rim from bead seat to bead seat.



The shape of well-based rims is provided by a letter code, such as J, K, JJ, and KK. The width of the rim and the diameter is traditionally stated in inches. A rim designated 7 JJ by 14 would refer to a rim measuring 7 inches across the rim flanges, and 14 inches in diameter from bead seat to bead seat, with the profile conforming to a JJ code.

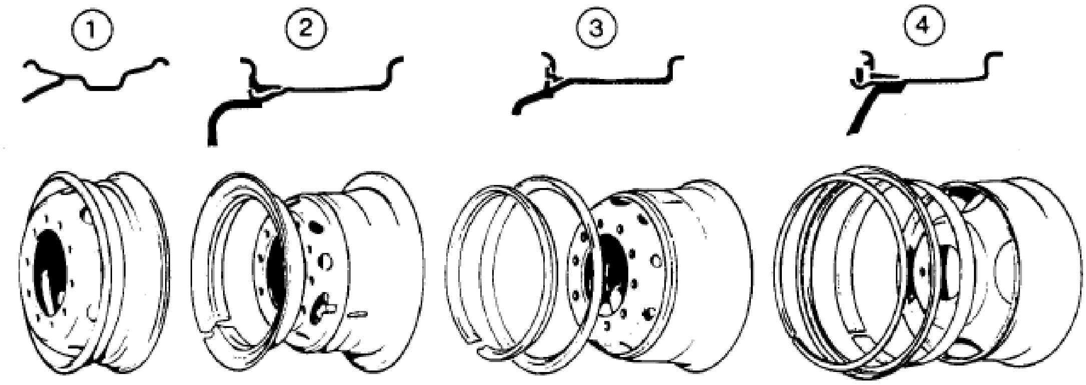
The rim width and diameter can also be stated in millimetres. Metric rims are not interchangeable with Imperial rims.

The tyre must be an exact fit on the rim, to fulfil a number of functions:

- It ensures that the narrow contact area between the beads of the tyre and the rim will seal the air in a tubeless tyre.
- It transfers all the forces between the tyre and the wheel, without slipping or chafing.
- It ensures the friction between the tyre and the rim prevents the tyre turning on the rim.

Rim construction

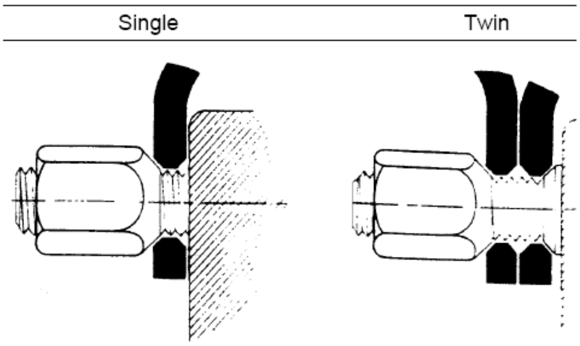
In order to carry heavy loads the side walls of the tyres must be very stiff and therefore very strong. This means that it would be difficult to remove the tyre by levering the bead over the flange. To overcome this, various types of rim construction are used. Wheel sizes are dependent upon the carrying capacity of the vehicle. The size is measured as a diameter across the wheel from rim to rim the most common being 50 cm (20 in) for heavy vehicles. A one-piece rim is generally used only on the smaller commercial vehicle but when tubeless tyres are fitted one-piece rims with a deep centre well are used on heavy goods and passenger vehicles.



Wheel Rim Profiles
1. Single Piece Wheel 2. Two Piece Wheel 3. Three Piece Wheel 4. Four Piece Wheel

3.4 Types of Wheel Fixings

British Standard

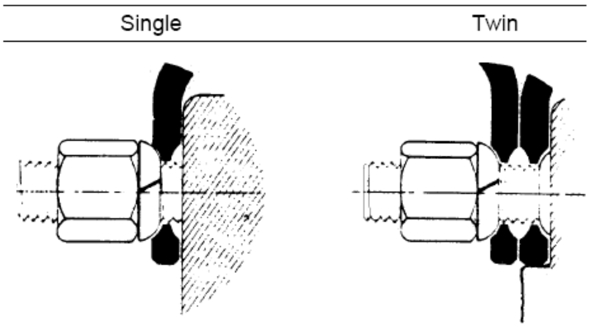


Wheel nuts: CONICAL taper

Stud holes: CONICAL countersink.

Location: By nuts seating in stud hole countersink. In most cases single wheels held flat onto hub. Inner twins on conical shoulder clear of hub.

Continental (DIN) Standard

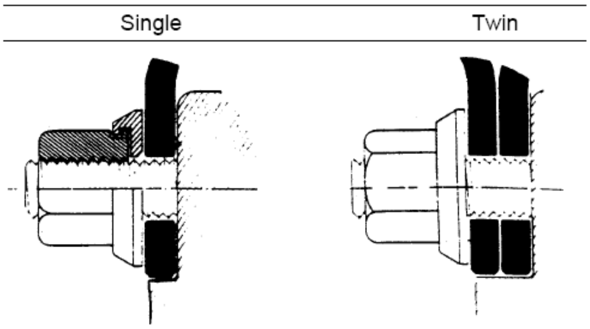


Wheel nuts: Plain used with SPHERICAL split washer.

Stud holes: SPHERICAL countersink.

Location: By nuts seating in stud hole countersunk. Both single and inner twin wheels held flat onto hub but inner twin partly located by spherical shoulder.

Spigot



Wheel nuts: Plain with FLAT integral washer.

Stud holes: Plain—no countersink.

Location: Close fit of centrebore on spigot. Both single and inner twin wheels held flat onto hub.

3.5 Tyre maintenance

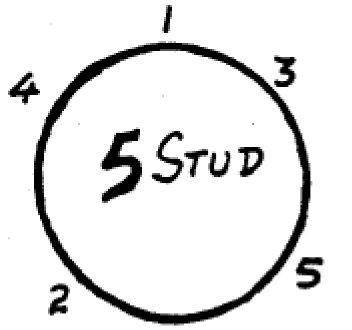
Wheel mounting

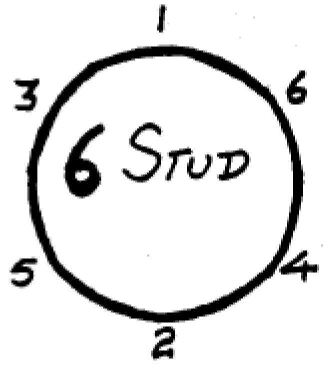
The standard disc wheels have countersunk stud holes, and they are carried on the conical or spherical faces of the studs and nuts, but are not supported

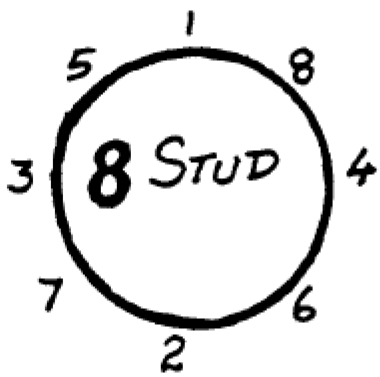
by the hub spigot which is smaller in diameter than the wheel bore.

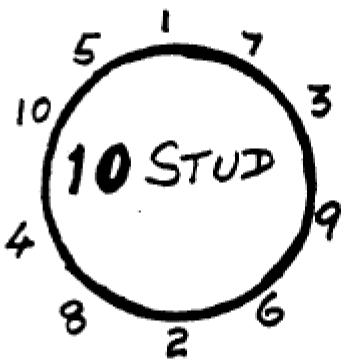
It is most important that during fitting the wheels should be centred correctly to avoid - overstrained or fractured studs, distortion of wheels, hub flanges and brake drums, loose wheels and elongated stud holes.

The vehicle must be jacked up so that the tyre is clear of the ground, push the wheel home on the studs and screw all the nuts lightly. One nut must never be screwed fully home while the others are still loose. The final tightening must be gradual and progressive by giving a short turn at a time to each nut in the sequence shown below, then torqued to manufacturers' specifications.









4.0 Tyre Construction and Design

4.1 Tyre Types

The tyre provides a cushion between the vehicle and the road to reduce the transmission of road shocks. It also provides friction to allow the vehicle perform its normal operations. Modern tyres are manufactured from a range of materials. The rubber is mainly synthetic. Two types of tyre construction are common – cross-ply and radial. Most passenger cars now use radial tyres, as do most 4-wheel-drives and heavy vehicles. Tube tyres require an inner tube to seal the air inside the tyre.

Tubeless tyres eliminate the inner tube by making the complete wheel and tyre assembly air-tight. A special, air-tight valve assembly is needed. This can be a tight fit into the rim, or it can be held with a nut and sealing washers.

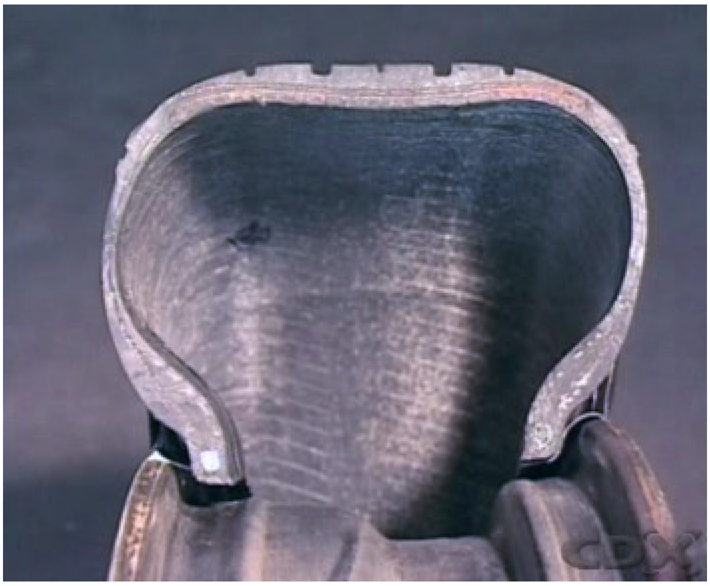
Tyres can be identified by markings on the sidewalls. This typically includes the maker's name, the rim size, the type of tyre construction, aspect ratio, maximum load and speed, and, in some cases, intended use. Regulations cover the allowable dimensions for wheels and tyres on a particular vehicle. These dimensions are usually set out on the tyre spec attached to the vehicle. Incorrectly selected wheels and tyres can overload wheel bearings and change steering characteristics.

The tyre chart lists the wheel and tyre sizes approved by the manufacturer for the vehicle.

Using other wheels and tyres may be illegal. The repairing of punctures on tyres must be carried out in accordance with current legalisation.

4.2 Tyre Construction

A tyre provides a cushion between the vehicle and the road, to reduce the transmission of road shocks. The air in the tyre supports the vehicle's mass, and the tread provides frictional contact with the road surface, so the vehicle can manoeuvre for normal use. Radial ply tyres are usually manufactured in stages. The casing is initially formed by laying the rubber inner, and the first layer of textile ply cords, around a flat drum mould. The rubber-covered bead wire and sidewalls are then locked into position.



The rubber sidewalls protect a finished tyre from kerb damage and weathering. At the second stage-building machine, the tyre is shaped. Belts of steel wire are guided into place. The tread is then positioned and the uncured tyre is consolidated by rollers, before it is placed in the mould. During the moulding and curing stage, the tyre is subjected to high temperature and pressure, and it takes on its final fixed identity, with its own distinctive tread pattern. It is then trimmed and checked for balance and quality before it is inflated, and run under load against a rotating drum. This is a final check for ride uniformity.

4.3 Cross-Ply Tyres

Two types of tyre construction are common, cross-ply and radial ply. The cross-ply tyre is the older form. It is also called a bias-ply or conventional tyre. It is constructed of 2 or more plies or layers of textile casing cords, positioned diagonally from bead to bead. The rubber-encased cords run at an angle of between 30 and 38 degrees to the centreline, with each cord wrapped around the beads. A latticed criss-crossed structure is formed, with alternate layers crossing over each other, and laid with the cord angles in opposite directions.

This provides a strong, stable casing, with relatively stiff sidewalls. However, during cornering, stiff sidewalls can distort the tread and partially lift it off the road surface, and that reduces the friction between the road and the tyre. Stiff sidewalls can also make tyres run at a high temperature. This is because, as the tyre rotates, the cords in the plies flex over each other, causing friction and heat. And a tyre that overheats can wear prematurely.

4.4 Radial Ply Tyres

Radial ply tyres have much more flexible sidewalls due to their construction. They use 2 or more layers of casing plies, with the cord loops running radially from bead to bead.

The sidewalls are more flexible because the casing cords do not cross over each other. However, a belt of 2 or more bracing layers must be placed under the tread. The cords of the bracing layers may be of fabric, or of steel, and are placed at 12, to 15 degrees to the circumference line. This forms triangles where the belt cords cross over the radial cords. The stiff bracing layer links the cord loops together to give fore and aft stability, when accelerating, or braking, and it prevents any movement of the cords during cornering. The cord plies flex and deform only in the area above the road contact patch.

There are no heavy plies to distort, and flexing of the thin casing generates little heat, which is easily dispersed. A radial ply tyre runs cooler than a comparable cross-ply tyre, and this increase tread life. Also, a radial tyre has less rolling resistance as it moves over the road surface.

4.5 Radial Ply Tyre Sidewalls / Thread

The sidewalls of radial ply tyres bulge where the tyre meets the road, making it difficult to estimate inflation pressure visually. It needs to be checked with an accurate tyre gauge. Using correct inflation pressures extends tyre life, and is vital for safety.

A tubeless tyre is lined with a soft rubber layer to form an air-tight seal. This inner liner also seals against small penetrations, letting air escape only relatively slowly. When a tubeless tyre is fitted, an air-tight valve assembly is used. It can be a tight fit into the rim, or be held with a nut and sealing washers.

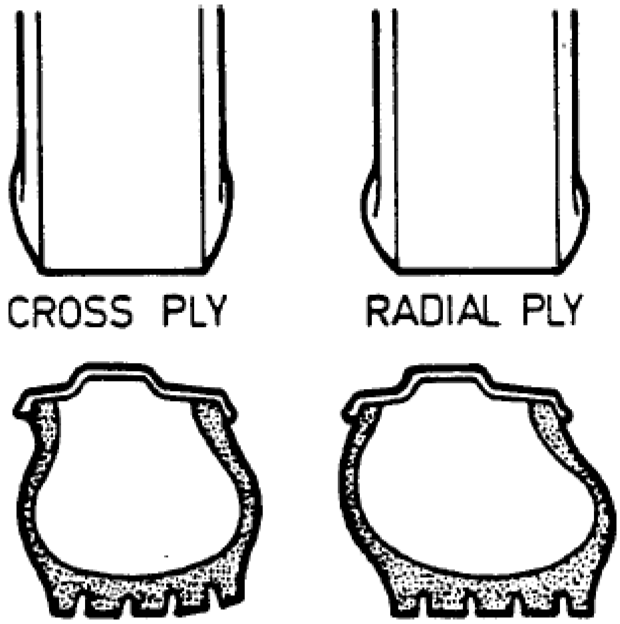
A tyre and wheel assembly must be balanced. As the wheel rotates, centrifugal force acts outwards. Any part heavier than the rest will vibrate vertically, with the heavy area slapping the road surface with each turn of the wheel. This is called static unbalance.

Dynamic unbalance causes the wheel assembly to turn inwards, and then outwards, with each half revolution. As speed rises, rapid side movement of the front wheels causes a sideways-vibration, or wheel wobble effect, at the front of the vehicle.

Tread life can also be reduced by incorrect wheel alignment. The feathered edge of this tyre indicates an incorrect toe-setting. And wear on the one shoulder of this tyre could be due to incorrect camber setting. Most passenger car tyres have tread-wear indicators moulded into the tread pattern. They generally provide an indication when the depth of a tyre groove falls to 1.6 millimetres legal limit.

Control of a vehicle in any weather conditions depends finally on frictional forces generated between the tyres and road surface.

In wet conditions, the coefficient of friction between a smooth tyre and the road surface falls to an extremely low value. Aquaplaning is prevented by Grooves in the tread pattern clearing water away from the contact patch area. This allows a relatively "dry area" to be formed, and for road adhesion to be maintained. The SI unit of tyre pressure is the "bar".



4.6 Tyre Materials

Modern tyres are made from a range of materials. The rubber is mostly synthetic, with carbon black added to increase strength and toughness. When used in the tread, this combination gives a long life.

Natural rubber is weaker than the synthetic version. It's used mainly in sidewalls. The plies are made from cords of fabric, coated with rubber. Manufacturers use a sophisticated selection process to create combinations that provide the required performance characteristics and 'hysteresis level' of the tyre.

Hysterisis can best be described as the energy lost, usually in the form of a build up of heat, when a section of vulcanized rubber is deformed in a regular, constant manner.

The more you subject a tyre to flexing and deformation the more heat will build up within the tyre. Excessive heat is the enemy of a tyre so this builds up has to be kept under control.

5.0 Tyre Information

5.1 Tyre Information

Information on tyre aspect ratio is now included in the sidewall marking, together with the type of construction, and the speed rating.

The speed rating of the tyre is given by the letter code, which indicates maximum recommended speed for that tyre. Common symbols for passenger car tyres include:

- S, for up to 180 kilometres per hour.
- H, up to 210 kilometres per hour.
- V, up to 240 kilometres per hour.
- And Z for over 240 kilometres per hour.

Radial ply tyres have always been marked with the section width in millimetres, but with the rim diameter in inches. For example:

- 185 is section width in millimetres.
- 70 indicate a 70% aspect ratio.
- H is the speed rating, for up to 210kilometres per hour.
- R indicates radial ply construction.
- 13 indicate the tyre is suitable for fitting to a 13-inch diameter rim.

Totally metric types are also manufactured. For example:

- 190 is the section width in millimetres.
- The aspect ratio is 65%.
- The speed rating is H, for up to 210 kilometres per hour.
- R indicates radial ply construction.
- 390 indicate the tyre is suitable for fitting to a 390 mm diameter rim.

Metric-diameter rims cannot be fitted with inch-diameter tyres, or vice-versa.

Although tyre markings may remain traditional, say 255, 45, Z-R 17, there is a worldwide move towards an ISO metric standard which uses letters:

- P for passenger
- LT for light truck
- C for commercial
- T means temporary use as a spare wheel.

The tyre may have a load index number, indicating the maximum load a tyre can carry at the speed indicated by its speed symbol, which follows the number.

So a P-series metric size code may read in full; P205/65, R15, 92H.

- P for passenger car tyre.
- 205 is the section width in millimetres.
- With 65% aspect ratio.
- R Radial ply construction.
- 15 inch diameter rim.
- 92 load index, for a maximum load of 630 kilograms.
- H for a speed rating up to 210 kilometres per hour.

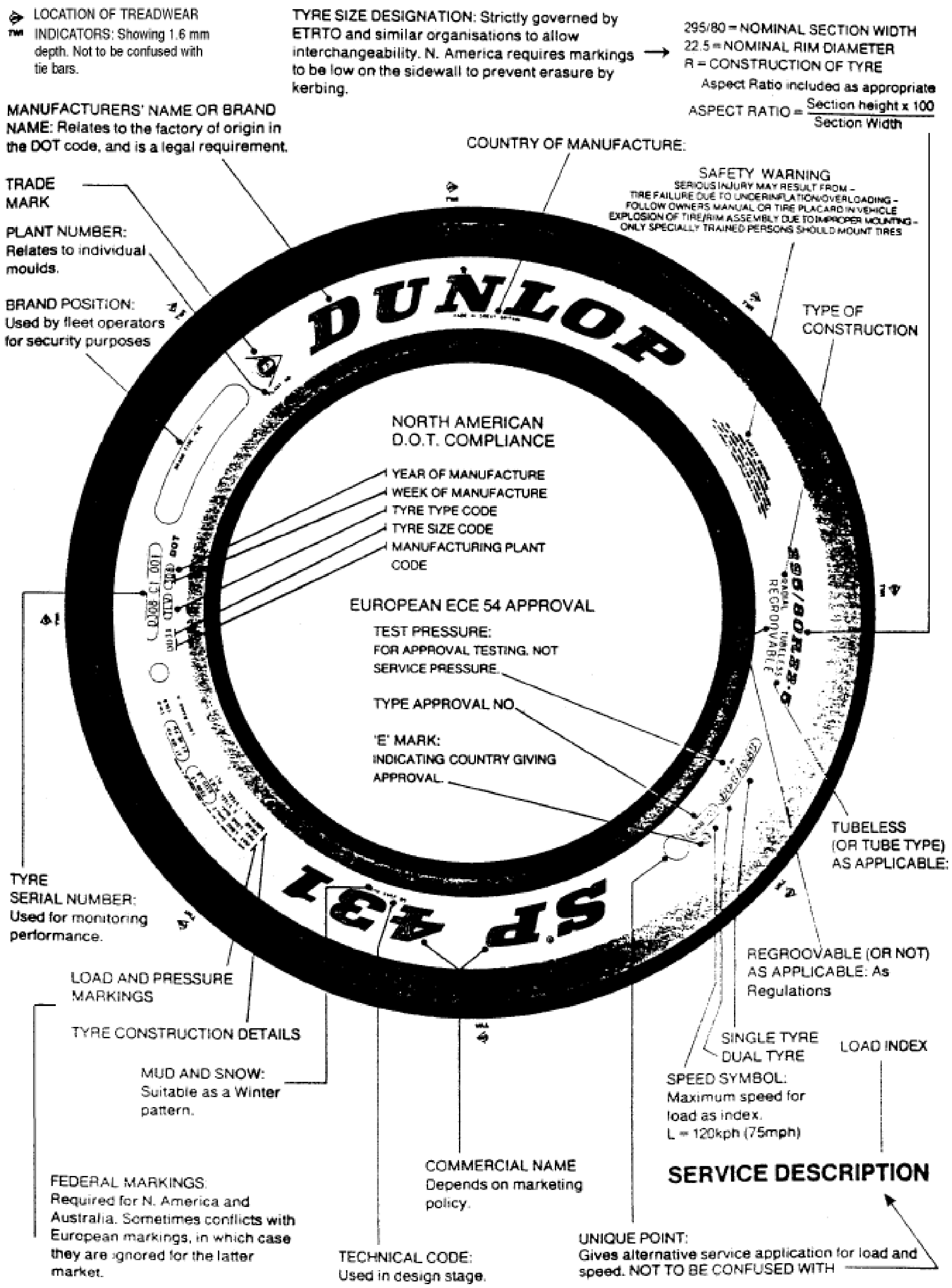
Further development of high-speed tyres has expanded the speed categories to include W, and Y.

In another example:

Z indicates a speed over 240 kilometres per hour, but the load and speed rating is taken as the maximum load and speed, that is;

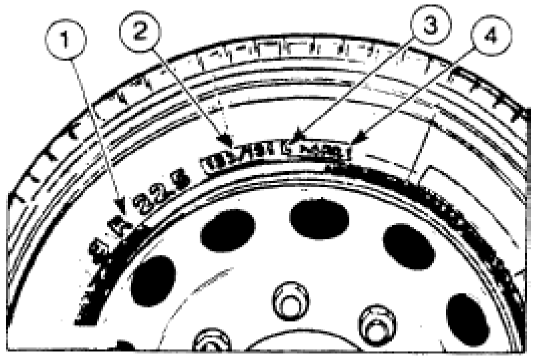
- 89 for a maximum load of 580 kilograms
- W for 270 kilometres per hour

Commercial vehicle tyres — sidewall markings



Tyre size

The sizes marked on a tyre refer to the width of the tyre and diameter of the rim to which it is fitted e.g. a 9.00-20 tyre is approximately 9 in wide and is fitted to a 20 in diameter wheel rim. The aspect ratio i.e. the ratio of width to height of tyre is approximately 1:1 with this type of conventional tyre. Most manufacturers now make an extra wide tyre – Super Singles - which can replace twin tyres. These have an aspect ratio of 0.65:1 with a typical size 15 - 22.5. This tyre can give better performance because of the larger surface area in contact with the ground and it is also lighter than the twin wheels it replaces.

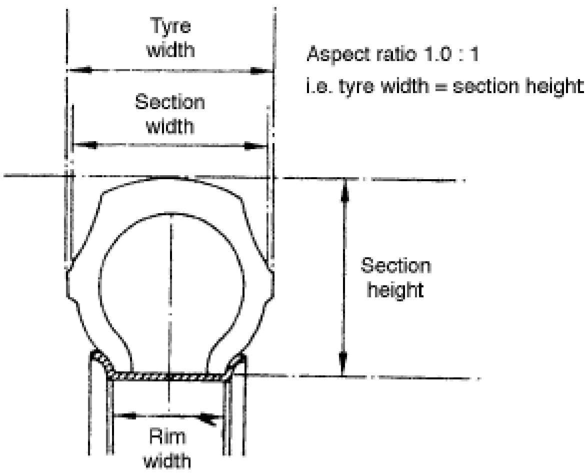


Typical Tyre Marking

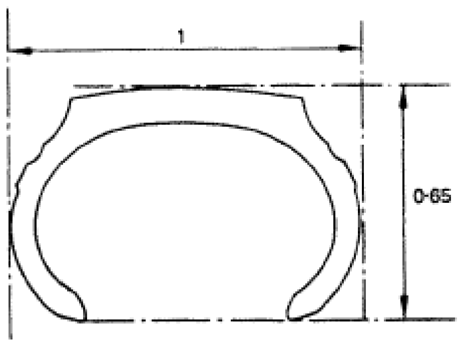
1. Tyre Size
2. Load index
3. Speed Symbol
4. Ply Rating

WARNING

Replacement tyres must not be lower speed rated than original equipment. Should any doubt exist about tyre fitment advice must be sought from either a reputable tyre dealer or manufacturer.



Tyre size and aspect ratio



Aspect ratio of a super single tyre

Speed Rating

The speed rating of a tyre may be determined by reference to the tyre speed symbol (see the chart below).

	Km/h	*mph*
J	100	62
K	110	68
L	120	74
M	130	80

Tyres bearing this symbol are not speed rated but are capable of being used at speeds up to 100 km/h (62 mph) maximum. If the vehicle is to be used at speeds in excess of this reference should be made to the manufacturer of the tyres to determine their suitability.

Load Index

The Load Index (e.g. 148/144) is a numerical code associated with the maximum load a tyre can carry at the speed indicated by its speed symbol under the specified service conditions. The higher number is the Load Index for the tyre when used In single formation The lower number is for twin wheel usage (see illustration).

Load Index	kg	Load Index	kg	Load Index	kg
100	800	120	1400	140	2500
101	825	121	1450	141	2575
102	850	122	1500	142	2650
103	875	123	1550	143	2725
104	900	124	1600	144	2800
105	925	125	1650	145	2900
106	925	125	1650	145	2900
107	975	127	1750	147	3075
108	1000	128	1800	148	3150
109	1030	129	1850	149	3250
110	1060	130	1900	150	3350
112	1120	132	2000	152	3550
113	1150	133	2060	153	3650
114	1180	134	2120	154	3750
115	1215	135	2180	155	3875
116	1250	136	2240	156	4000
117	1285	137	2300	157	4125
118	1320	138	2360	158	4250
119	1360	139	2430	159	4375

Tightening torques

Wheel Nuts

	Nm	kgm	lbft
6/8/10 stud (SMMT type)	575	59	424
6 stud (M type)	380	39	280
8 stud (M type)	465	47	343
10 stud (M type)	575	59	424

5.2 Tyre Sizes & Designations

The size of a tyre must satisfy some basic conditions. The bead diameter must suit the wheel rim diameter. Section width must be suitable for use on the wheel rim, and large enough to have a suitable load-carrying capacity for the vehicle. The overall tyre size must allow sufficient clearance between the tyre and the vehicle frame. All manufacturers mould information about the tyre into its sidewall.

In cross-ply tyres, the bead diameter and the section width are stated in inches. For example, six hundred by sixteen indicates a tyre with a section width of 6 inches and a bead diameter suitable for fitting to a rim which is 16 inches in diameter, across the bead seats.

The load capacity is indicated by the ply rating, for example, 6PR. The aspect ratio of a tyre is the ratio of its height to its width. It is usually given as a percentage. The lower a tyre's aspect ratio, the wider the tyre is in relation to its height.

An aspect ratio of 98% means the section height of the tyre is slightly less than the section width. This is called a cushion or balloon tyre. An aspect ratio of 88% means the height is 12% less than the width, giving a lower profile. It is called a medium low profile tyre. The profile of cross-ply tyres was reduced further to between 78% and 82%, called a super low section. However the stiffness of cross-ply tyres makes them unsuitable for further reduction in profile.

Radial ply tyres have been manufactured in 78% profile, but are also made with further reductions in profile, from 75%, to 45%.

5.3 Tyre Ratings for Temperature & Traction

One of the markings on the sidewall of a tyre is a **Uniform Tyre Quality Grading** or UTQG grade.

The tyre's UTQG rating provides information on three aspects of the tyres durability and operational characteristics. They are;

- tread wear,
- traction and
- temperature.

The tread wear number comes from testing the tyre in controlled conditions. The higher the number, the longer the life expectancy of the tread. Since no one vehicle will be subjected to exactly the same surfaces and at the same speeds as the controlled conditions, the number can only be an indicator of expected tread life in "normal conditions".

Summary

A Uniform Tyre Quality Grading or UTQG grade provides information on tread wear, traction and temperature.

5.4 Tyre Tread Designs

Tyres generally fall into one of the following categories;

- Directional,
- non-directional
- and Symmetric and Asymmetric.

Directional tread patterns are designed to provide a range of attributes during particular driving conditions. The tyre can only be mounted to the wheel so that it revolves in a particular direction to correspond with the tread pattern. An arrow on the tyre sidewall indicates the designed direction of forward travel. On-directional tread patterns are designed in such a way that the tyre can be mounted on the road wheel for any direction of rotation.

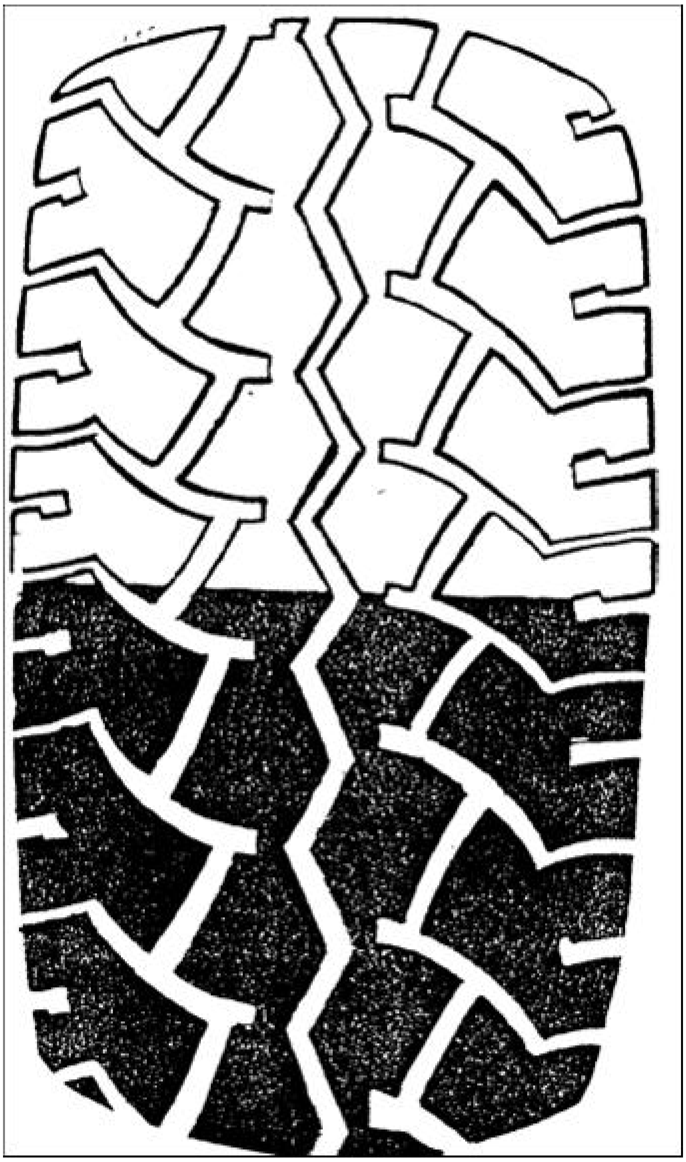
Summary

Tyre treads can be directional, non-directional, symmetric and asymmetric.

5.5 Tread pattern

One of the major requirements of a tyre is good tread life, which must also be allied to a pattern design that will give the traction and performance needed for its particullar operational use.

Road Shuffle which stems from the tyre flexing under load, a big factor in treadwear, and so a plain tread with no pattern whatsoever would provide the best wearing qualities on hard dry roods. Because wet roads and loose surfaces will be encountered however, a tread pattern must be incorporated.



The example pattern shown here displays a centre pattern of ribs and grooves running circumferentially, with cross grooves extending towards the edges. The central ribs would give good wear and good cornering grip, whilst the cross groves would provide for braking and traction.

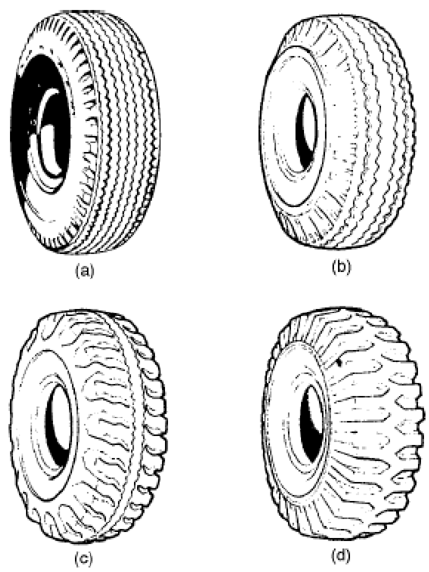
Grip

The right tyre for the right job.

Hard Surface (Road)	-	Ribbed Pattern
Soft Surface (Off/Road)	-	Lugged Pattern
On/Off Road Combined	-	Rib/Lug Pattern

Reliable service

Reliable service is of primary importance to all. No matter how good a tyre may be, its performance is governed by the conditions it operates under (e.g. pressures, roads, correct fitment etc.). The ability to give long and reliable service depends not only on the tyre itself, but to a large extent on correct inflation pressures and correct load.



(a) Rib pattern - a general-purpose high-speed tyre. Ribs in a zigzag pattern.

(b) Reinforced side walls with a scuff band are used for tyres on local deliverys work. A simple zigzag pattern is used.

(c) A multi-purpose tyre for on and off the road application uses a combination of ribs and cross bars. The cross bars give increased traction and the ribs give lateral stability.

(d) An off the road tyre usually uses staggered cross bars for grip and slightly inclined to give a self-cleaning action.

6.0 Run Flat Tyres

The major safety benefit of Run Flat technology or RFT is that it enables a driver to maintain control if a vehicle in motion suffers a rapid loss of tyre pressure. In addition, RFT tyres enable the driver to continue the journey within specified speed and distance limits, avoiding the need to replace the wheel on the side of the road.

Tyre manufactures also maintain that, as an added benefit of RFT they usually save weight by eliminating the need to carry a spare tyre. However, because of their construction they are generally between two to three times heavier than their conventional counterpart, which adds additional un-sprung weight to the vehicle affects the suspension and can increase fuel consumption. Because of the extra materials used in construction of the tyre, they are also normally more expensive to purchase. In addition, run flat tyres are usually "harder riding" and noisier in operation which can be a disadvantage in some applications. From a manufacturing perspective however, the free space created by eliminating a standard spare wheel gives the car manufacturer a range of additional design opportunities.

An "onboard" vehicle tyre pressure monitoring system (TPMS) is normally mandatory for all RFT applications. Run Flat Technology design features generally focus on two aspects of operational use - rigidity and heat resistance. This is to enable the tyre to support vehicle weight when it is rotating with a total air loss.

Some run flat tyres are known as "Extended Mobility Technology" or "EMT" tyres. EMT sidewalls can be six times thicker than traditional tyres. As a result the manufactures say that EMT "Run flat" tyres can be driven at speeds of 55-miles or 80-kilometers per hour for up to 200 miles or 300 kilometres in a deflated condition before being damaged.

They normally have a directional tyre pattern which must be fitted in such a way that the tread rotates only in one direction. Specialized equipment is needed to fit Run flat tyres as the sidewalls are stiffer and thus not as pliable when fitting. Whilst the tyres are described as "Run flat", they are not indestructible. Major damage that slices the tyre casing can still result in complete tyre failure.

Summary

Run Flat technology or RFT tyres enable a driver to maintain control if a vehicle in motion suffers a rapid loss of tyre pressure.

6.1 Tyre Pressure Monitoring System (TPMS)

Maintaining proper tyre pressure is essential for the safety and performance of a vehicle. It also plays a significant role in decreasing fuel consumption and extending tyre life. All tyres lose inflation over time and, as many modern vehicles have extended service intervals, tyres can become dangerously under-inflated without regular checking by the vehicle driver.

In addition to increased fuel consumption and tyre wear, long periods of driving with low tyre pressures can cause additional stress on the tyre sidewalls. This results in increased operating temperatures that can lead to premature tyre failure. Tyres operating with low pressures can also affect the vehicle's handling and performance. In a worst-case scenario, under-inflation can lead to a tyre blow-out or tread separation.

Automated Tyre Pressure Monitoring Systems or TPMS provide a means of reliable and continuous monitoring of the vehicle tyre pressure and are designed to increase safety, decrease fuel consumption and improve vehicle performance.

There are two types of tyre pressure monitoring; direct and indirect.

The direct monitoring system uses a pressure sensor mounted inside each wheel and uses a wireless transmitter to give direct tyre pressure readings.

The indirect system uses the vehicles wheel speed sensors to determine if a tyre is under inflated when compared to each of the other tyres.

TPMS can be fitted to all vehicle types using conventional and run-flat tyres.

With a Tyre Pressure Monitoring System installed on a vehicle, drivers can monitor the tyre pressures and temperatures from the driver's seat to ensure that their tyres are properly inflated under all operating conditions. The systems are also designed to ignore normal pressure variations caused by changes in ambient temperature.

The sensor installed inside each wheel is able to respond to as little as a 3PSI or 20Kpa drop in pressure. Real-time information is sent via wireless signal to a display in the vehicle. If a fluctuation occurs, an audible and visual warning instantly alerts the driver allowing time for the vehicle to be stopped or driven to a service station for tyre repair or re-inflation. The tyre is used to enclose the unit as protection from the outside environment. An on-board computer receives the radio messages from the sensors, which are coded for individual wheel identification.

The interactive display inside the vehicle shows:

- The required tyre pressure
- The actual tyre pressure
- The tyre pressure status
- The temperature of the tyre

The driver can use the display control buttons to check the status of each tyre.

In OEM installations, each time the ignition is switched on, an indicator on the instrument panel and on a system display provides information about all four tyre pressures, and gives a "Pressure OK" message if all is well. An indicator on the display will “flash” whenever pressure loss is detected. In the case of minor deflation, an orange "Service" light is shown, and indicates the faulty tyre. If the pressure is dangerously low, a red "Stop" light flashes, accompanied by a punctured tyre icon, indicating that an immediate wheel change is needed.

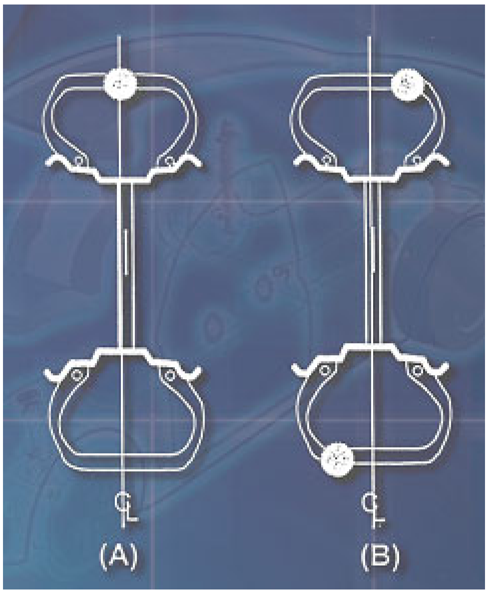
The sensors are activated by a centrifugal switch and transmit only when the vehicle is in motion. When the vehicle stops the sensors return to sleep mode to extend battery life, however the driver is still able to review the latest signals received from the wheels before the vehicle was stopped.

7.0 Wheel Balancing

Imbalance is an uneven distribution of mass about the tyre/wheel centre-line. Balancing is an essential process when fitting new tyres to wheels or after the tyre has been removed and then refitted to the rim. Most standard production tyres and wheels will, when built, have slight imbalances in their construction due to the nature of the manufacturing process. Balancing allows the technician to determine where these "heavy" spots are located and counteract the effect with balance weights.

An imbalance in a tyre/wheel assembly can usually be noticed as one of two things. Firstly an imbalanced front wheel will give a vibration that can be felt through the vehicle steering wheel. Secondly, an imbalance in the rear wheels will result in a vibration that can be "felt" through the vehicle body. As well as being uncomfortable this imbalance can have a detrimental effect on the vehicles handling and may also be noticed as slightly increased fuel consumption due the constant change in wheel speed

Wheel balancers will check two kinds of balance, "static" (A) and "dynamic" (B). Static imbalance causes a wheel to shake up and down (wheel hop) as it spins, so static balance is achieved when both halves of the tyre wheel assembly weigh exactly the same. Dynamic imbalance causes a tyre and wheel to shake back and forth or sideways as it spins (wheel shimming). Dynamic balance is achieved when the inner and outer sides of the wheel and tyre weigh the same.



8.0 Space-Saver Wheels

Space-saver spares are designed for emergency use only. They're designed to get you to a service centre where you can have the regular tyre fixed or buy a new one. When provided with the vehicle as part of the original manufacturer's equipment, most manufacturers warn not to exceed 50 miles or 80 kilometres per hour and 50 miles or 80 kilometres of driving on the space saver tyre.

Some cars are provided with miniature or collapsible space-saver spare tyres as spare wheels. These normally require a specially charged canister for inflation when being installed. Others have small, temporary spare tyres that are inflated normally with a compressed air supply but to a much higher pressure than normal road tyres.

Note: Space-saver tyres are designed for emergency use only.

9.0 Tyre Maintenance & Wear Diagnosis

9.1 Checking for Tyre Wear Patterns

9.2 Part 1: Preparation and Safety

Objective

Check tyre for correct wear pattern and ensure there are no embedded foreign objects in the tread.

Safety Check

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 instructor.

Points to Note

Some manufacturers supply an emergency rim assembly instead of a full-size spare. It is not intended for long-term use or high speed, but it must have adequate tread.

9.3 Part 2: Step-by-Step Instruction

Check for foreign objects and pressure - Inspect the tyres for embedded objects in treads and remove them, and look for signs of wear on all wheels, including the spare. Check the pressure in the tyres.

Check tread wear depth - most tyres have wear indicator bars incorporated into the tread pattern. Inspect the wear indicator bars. Tyres should have at least one sixteenth of an inch, or two millimetres of tread remaining. The wear indicator bars are normally set at this depth. If the tread is worn down to that level or below, they are unserviceable and must be replaced.

Check tread wear pattern - Check the wear patterns with the vehicle's shop manual to indicate the types of wear that have occurred. Causes of uneven wear can include faulty shock absorbers, incorrect front alignment angles, and wheels out of balance. Uneven tread and bald spots can indicate over- or under-inflated tyres and poor alignment.

Check tyre for damage - Inspect the sidewalls of the tyres for signs of cracking from impacts with blunt objects. Carefully examine the tread area for separation. This is usually identified as bubbles under the tread area. Spin the wheel and see if it is running true. If it is wobbling as it rotates, report it to your supervisor.

9.4 Tyre service

Tyre pressures

- **Heat** - the greatest **Killer** of Tyres—caused mainly by **Under Inflation** which causes overflexing of the tyre casing, which in turn leads to premature failure.
- Strict attention must be kept to **Pressure** Maintenance at all times - **Spot Checks** should be carried out on an ongoing basis when the tyres are cool.
- **Valve Dust Caps** must be always fitted to keep grit/dirt and moisture from damaging the **Air Seal.**
- **Under Inflation or Over Inflation – Not On** - Only use recommended pressures.

Tyre fitting

- Where **Twinned Rear Wheels** are fitted, care must be taken to ensure that the valve necks are always correctly positioned so that they are easily accessible for checking and inflating. It is also important that both tyres have similar wear when twinned.
- **Dusting Chalk** must always be used when fitting a tube as it will prevent the tube from creasing and sticking to the inside of the tyre.
- It is important that when fitting a tube that the valve neck is correctly positioned so that there is no strain on it. Always ensure that the correct type of valve neck is used to suit the rim - **Rubber** - **Metal** - **Straight** - **Bent** - **Long** - **Short**.
- When fitting **New Tyres – Always Fit New Tyres** as tubes tend to stretch and grow during service, which can lead to creasing and cracking when refitted.
- **Never** stand over a wheel when **Inflating.**
- **Always** use a **Safety Cage** when inflating a **Truck Tyre** off the vehicle.
- **Never** refit Distorted or Cracked wheel Flanges or Locking Rings.

9.5 Tyre maintenance

Repairs

Never Fit more than **3 Patches** on a **Tube**

When fitting new **Valve Necks** in tubes - cut out the old valve, removing the rubber base by buffing down Position the Repair Valve over the existing hole and vulcanise.

SECONDRY DAMAGE can show up as a bulge when its at an advanced stage.

In some cases it may be advisable to patch the original hole in the tube and relocate the new valve. In this situation a small new hole should be cut in a corresponding position on the tube and the new valve vulcanised over it.

Always ensure that the surfaces for vulcanisation are spotlessly clean and free from dust and dampness. The surface should be buffed down to allow a correct bond.

In a **Steel Radial Tyre** a penetrating object can very often cause bits of broken wire to protrude into the tyre which can puncture the tube when it is refitted.

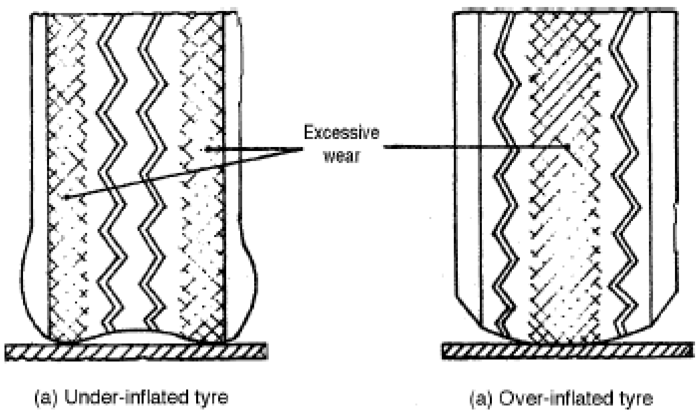
Always check damage fully.

Tubeless Tyres must be removed from the rim to be fully checked before repairing. Secondry damage could be caused by penetrating object.

Incorrect Tyre Pressures can cause uneven wear

Under Inflation: outer treads worn. Resulting in overheating.

Over Inflation: center tread worn. Resulting in a less flexible casing more prone to impact fractures.



Wear with incorrectly inflated tyres

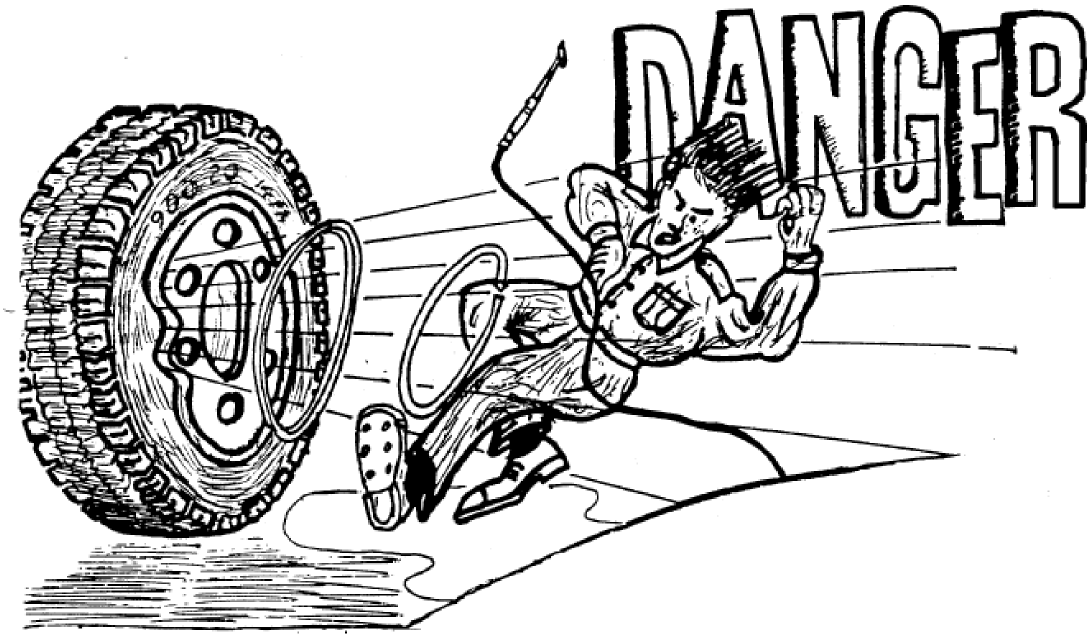
Tubeless versus **Tubed Tyres**

Tubeless tyres: better air retention—less chance of blow out or immediate deflation —cooler running—safer.

Tubed tyres: Requires more frequent topping up of air Instant deflation when penetrated, more susceptible to blow outs.

IMPORTANT

Brazing, Soldering, or Welding Repairs to wheels are not recommended, but if these are attempted the tyre MUST be completely dismounted from the rim and not just deflated, otherwise serious distortion and damage of the tyre can occur. The tyre should only be refitted when all the heated components have fully cooled down.



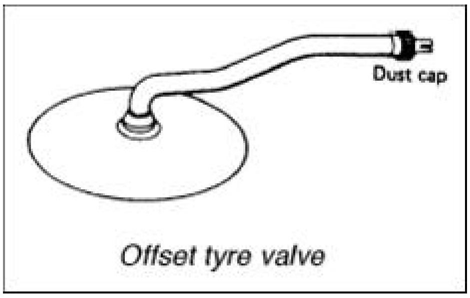
Fixed guard

Portable guard

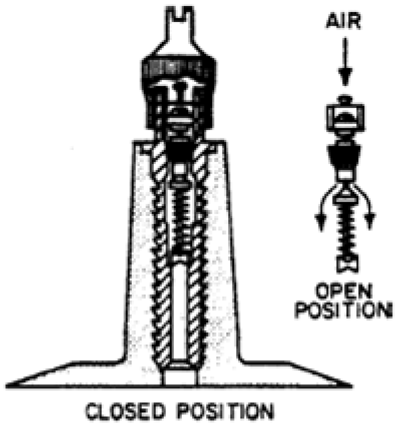
9.6 Valves

The valve retains the air in the tube or tubeless tyre. It is a small unit but its efficient functioning is very important. It has three component parts:

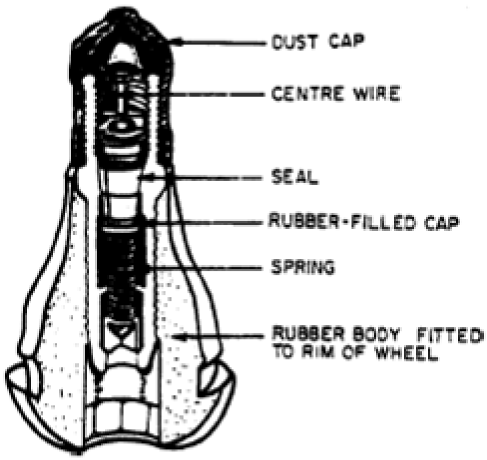
- The rubber-covered valve stem.
- The core, which is the primary seal.
- The cap, which acts as an extra air seal and prevents entry of dust, grit or water.



The valve is closed by a spring and air pressure inside the tube/tyre which presses the seal against the valve seat.



Tubed Tyre



Tubeless Tyre

10.0NCT Requirements

Refer to Item 36 to 40 of NCT manual 2004.

SOLAS
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