Tyre Selection and Maintenance in Ports and Terminals

A PEMA Information Paper

Tyres have a significant, often overlooked, impact on the cost, reliability, safety, energy usage and emissions of port vehicle and handling equipment fleets.

The goal of this Information Paper is to provide ports, terminals and other interested parties with information on the main types of tyres available for port equipment, the most common causes of damage and loss, and how to reduce costs, damage and accidents through correct selection, inspection and maintenance of this vital component.

PEMA
PORT EQUIPMENT MANUFACTURERS ASSOCIATION

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INTRODUCTION

DOCUMENT PURPOSE

This Information Paper is intended to provide an overview of the key considerations in the selection, inspection and maintenance of tyres for port vehicle and handling equipment fleets.

The goal is to provide ports, terminals and other interested parties with information on the types of tyres available for port equipment and the most common causes of damage and loss, together with practical advice on how to reduce costs, damage and accidents through correct selection, inspection and maintenance of this vital component.

Proper selection, inspection and maintenance of tyres will have positive impact on users' bottom line, operating performance, safety and environmental stewardship.

PEMA cannot advocate or decide which tyre solution is the right choice for any particular facility. However, the intent here is to contribute to industry awareness of the issues and options that ports and terminals should consider when making their selection, and putting their inspection and maintenance programmes in place.

ABOUT THIS DOCUMENT

This document is part of a series of Information Papers developed by the Safety Committee (SC) and Environment Committee (EVC) of the Port Equipment Manufacturers Association.

The SC series is intended to inform readers about the design and use of equipment and technology to improve the safety of people, equipment and cargo in port and terminal operations.

The EVC series is intended to inform readers about the design and use of equipment and technology to reduce energy consumption, enhance sustainability and minimise the environmental impact of port and terminal operations.

This current paper is a joint effort between the two committees.

This document does not constitute professional advice, nor is it an exhaustive summary of the information available on the subject matter to which it refers.

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1 | BACKGROUND

1.1 TYRES - WHY DO THEY MATTER?

The selection and maintenance of tyres has a significant impact on the cost, reliability, safety, energy consumption and emissions of vehicle and equipment fleets. In the port and terminal market, tyre replacement ranks second only to energy expenditure in operating costs. Tyres thus constitute a critical component of modern port and terminal fleet operations and warrant detailed consideration.

In choosing the right tyres for port vehicles and equipment, a number of factors must be balanced. These include mileage, operating safety and reliability across a variety of changing conditions, plus ease of maintenance and, of course, purchase price.

Users will also need to evaluate how robust a tyre is to withstand conditions such as load transfers and the presence of foreign objects, plus its ability to minimise shock and vibration, providing enhanced handling and a smooth ride for the frailest part of the system: the driver.

Choosing the most appropriate tyre for the specific application and equipment type is essential, especially as safety can be all too easily compromised. The huge pressures involved in the port tyre market can and do result in injuries and fatalities in case of a blowout.

Furthermore, equipment such as reach stackers, straddle carriers, heavy-duty forklifts and empty container handlers rely on their tyres to absorb or counter some of the forces inherent in carrying high, off-centre loads.

Correct tyre selection and maintenance also have a considerable impact on energy consumption and emissions. It is estimated that some 20% of a harbour vehicle's energy consumption can be attributed to the rolling resistance of its tyres.

Finally, the cost impact of incorrect maintenance must not be underestimated. This applies especially to correct management of inflation pressures, one of the most important elements for maximising tyre life, minimising fuel consumption and ensuring safe operations. A tyre inflated to 70% of its recommended air pressure will most likely have its lifetime cut by more than 50%.

Sadly, there is some evidence that pressures to cut down on costs may be pushing some port maintenance staff to try cheaper or unsuitable tyres on handling equipment in a bid to either save time or money, although the resulting downtime and, if the accident is serious, the ensuing investigation can seriously affect the whole port.

1.2 PORT TYRES - A DISTINCT ROLE

Port tyres are obviously very different from domestic tyres, due to the huge loads they are designed to carry. They can also diverge from the commercial truck market and have differences of application even within the port, so elements such as load indices need to be treated with care.

For example, large truck tyres for road use may have to withstand a single wheel load of up to 3,000kg. With a load rating of 146 these can be inflated to around 8.5 bar, but these kinds of truck tyres are designed for highway speeds and conditions.

By comparison, a 105cm industrial tyre on a terminal tractor with a load index of 172 and inflated to 10 bar is designed to take loads around 8,100kg when running at 10km per hour. It is worth noting that at 25km per hour this drops to 7,100kg.

In contrast again, a larger 169.4cm tyre on a reach stacker with load index of 207 inflated to 10 bar can take loads of around 23,000kg when running at 10km/h.

1.3 TYRES IN PORT OPERATIONS - A BRIEF HISTORY

The evolution of the port tyre market has been driven by diverse influences. The first and foremost of these is containerisation.

Handling equipment innovation began to take off with rise of containerisation in the 1970s. As standardisation became possible, terminal operators

developed more efficient yard configurations and specialised handling equipment and vehicles came onto the scene.

At first the equipment of the 1970s and 1980s simply utilised the nearest possible source of tyres from the haulage industry. However, it was soon recognised that port operations had very specific challenges, including slow speeds, rough terrain and difficult marine climatic conditions, all combined with heavy loads which need to be manoeuvred at height and outreach. Since then, there have been a number of dedicated port-related developments, with tyres becoming increasingly diverse and specialised in their characteristics.

The growth in vessel sizes and call exchanges, coupled with the need to optimise turnaround times, have also increased the performance demands placed on port equipment and vehicle tyres, spurring various new technology developments in response.

The heavy demands placed on port tyres in general and the distinct usage challenges for different types of equipment and vehicles, plus the various tyre technologies now available, mean that today's procurement personnel and maintenance engineers need a much more detailed level of understanding in order to make the correct choices.

1.4 TOWARD THE FUTURE

The drive for reduced energy usage and emissions, better safety and greater operational predictability, plus a drop in the upfront cost of investment, is spurring an increasing number of terminals to move toward automated operations and/or non-fossil fuel power sources such as batteries or fuel cells.

However, these new types of operation potentially make a larger demand on vehicle tyres. Both electric-battery units and automated handling equipment can show a tendency to accelerate and brake more sharply than their more traditional fossil fuel- and human-driven counterparts, if elements such as acceleration sensors lose clarity.

2 | HANDLING EQUIPMENT TYPES AND KEY CHALLENGES FOR TYRES

The variety of equipment in ports has evolved into a number of operations, each with specific challenges for the tyres.

2.1 EMPTY CONTAINER HANDLERS

While carrying limited weight, empty container handlers have to cope with the extreme 15-17m height reach of their loading masts, creating a high bearing on the front axle. Rear tyres also come under pressure from the large counterweight required to ensure vehicle stability.

The relative instability of this equipment type is also an issue, in particular when turning sharply with elevated loads or encountering potholes. Manoeuvres with elevated loads stress the tyres and, in sharp turns, a 'kissing' effect can take place between the dual front tyres' inner facing sidewalls.

Empty container handlers also tend to be driven at higher speeds than other terminal equipment, heightening the effects of the issues listed above. In extreme cases, all of this can lead to sudden tyre failure with potentially fatal consequences.

Graphic: Empty container Handler

2.2 HEAVY DUTY FORKLIFTS

Heavy-duty forklifts - which themselves weigh in excess of 20 tonnes - can be required to move large loads of nearly the same weight again. Since the load can be elevated to 5m and concentrated on a single axle, there are issues with occasional lack of stability.

Graphic: Heavy Duty Forklift

2.3 REACH STACKERS

With an unladen weight of 70-80 tonnes a reach stacker handles enormous loads on single axles. Furthermore, payloads are also often heavier than indicated and this needs to be taken into consideration, especially since containers can potentially be lifted to heights of up to 12m.

Graphic: Reach Stacker

2.4 MOBILE HARBOUR CRANES

In contrast to other port equipment, mobile harbour cranes (MHCs) do not place a burden on their tyres when handling loads, but their weakness is the enormous unladen weight during moves – up to 600 tonnes.

In addition, MHCs are static for long periods, and in some climates particular areas on the tyre can be more exposed to UV radiation than others, accelerating the ageing process of the rubber. When MHCs are moved, it is often in a regular pattern along a straight line, so the impact from uneven surfaces such as rails and curbs is focused on certain areas. As a result, it is not uncommon for these tyres to fail well before their projected service life.

Graphic: Mobile Harbour Crane

2.5 RUBBER TYRED GANTRY CRANES

The enormous weights on rubber-tyred gantry crane (RTG) tyres come from both the weight of the payload and the weight of the crane itself. Like mobile harbour cranes, these cranes travel quite modest distances at lower speeds, but are subjected to some particular issues.

Firstly, they can be required to turn on the spot under load and at an extreme 90 degree angle. In contrast to other vehicles, an RTG does not move when its wheels are turned – a factor that adds tremendous stress to the tires.

Secondly, the lack of movement can cause problems similar to those encountered by MHC tyres, with UV exposure issues and constant loads on the same area of the tyres leading to flat spots. When the deformed carcass is moved, the wear increases exponentially. Tyres fitted to RTGs which are parked for long periods should have the weight jacked off the tyres and covered to protect them from direct light.

Graphic: Rubber Tyred Gantry Crane

2.6 STRADDLE CARRIERS

Straddle carriers typically have an unladen weight of 70 tonnes and operate at speeds of up to 30kph, with loads being held 25m in the air.

One of the key issues for this type of equipment is that hard braking can bring on a rocking and swaying motion. As the ‘slip-stick’ effect causes single tyres to lose surface contact, the vehicle starts to make uncontrolled movements. The worst case scenarios lead to the load twisting and the vehicle tipping over, with potentially fatal results.

For this reason, the damping properties of the tyres are crucial. However, only a tyre with the necessary and correct stiffness can prevent the slip-stick effect.

Graphic: Straddle Carrier

2.7 TERMINAL TRACTORS

Terminal tractors clock up the highest mileage of all handling equipment, with the associated acceleration, braking and cornering that this implies.

Uneven surfaces with different and sometimes highly abrasive surfaces, potholes, bumps and foreign objects all increase tyre wear and the potential for failure. For some terminals, a good grip on wet or slippery surfaces, including ramps and rails, is also an issue. However, in the case of terminal tractors the failure rate rises simply because there are many instances where terminal operators are using road tyres instead of dedicated varieties.

2.8 AUTOMATED GUIDED VEHICLES

Automated guide vehicles (AGVs) usually face moderate speeds of up to 20kph with gradual bends, making the demands on AGV tyres seem quite low. However, other factors need to be considered, including the weight of batteries.

There is also the effect of the 'missing human element'. Unlike a manned unit, an unmanned AGV cannot avoid foreign objects.

Graphic: Automated Guided Vehicle

Graphic: Terminal Tractor

SUMMARY OF EQUIPMENT TYPES AND KEY ISSUES FOR TYRE USAGE

Equipment type	Key characteristics, risks and impact for tyre usage
Empty container handlers	• Tall loading mast - high bearing on front axles • Large counterweight - pressure on rear tyres • Manoeuvres with elevated loads - tyre stress • Sharp turns at speed and with high load - can cause 'kissing' effect between dual front tyres' inner facing sidewalls • High speeds - heighten the effect of other factors
Heavy duty forklifts	• High combined weight of equipment and container – tyre pressure • Elevation of laden containers up to 5m – as above
Reach stackers	• Very high loads exerted on single axles – tyre pressure • Lifting heavy loads at heights of up to 12m – as above
Mobile harbour cranes	• Very high unladen equipment weight of up to 600 tonnes – extreme tyre pressure during moves • Equipment static for long periods – greater risk of exposure to UV radiation, accelerating ageing of the rubber • Crane movement often in a regular pattern along a straight line - impact of uneven surfaces (rails, curbs) tends to be repetitively focused on certain tyre areas • High risk of tyres failing well before projected service life
Rubber tyred gantry cranes	• Very high weight of crane and load – extreme pressure on tyres • Crane can be required to turn on the spot under load and at 90 degree angle – tyre stress • Crane does not move when its wheels are turned – tremendous additional stress to the tyres • Lack of movement can cause problems with UV exposure degrading tyre rubber • Constant loads on the same area of the tyres can lead to flat spots
Straddle carriers	• High unladen weight up to 70 tonnes • Speeds of up to 30kph while carrying laden containers at heights of up to 25m • Hard braking can cause 'slip-stick' effect where single tyres lose surface contact – loss of vehicle stability and risk of tipping • Selection of stiff tyre with good damping properties is crucial to counter 'slip-stick' effect
Terminal tractors	• Highest mileage of all handling equipment – high usage • Regular stress from acceleration, braking and cornering • Frequent travel over uneven and different surface types with potholes, bumps and foreign objects - increases tyre wear and potential for failure • In some climates, need for good tyre grip on wet or slippery surfaces, including ramps and rails • Industry tendency to use road tyres rather than speciality tyres leads to higher failure rates
Automated guided vehicles	• Weight of batteries in electric units • No human control - unmanned AGVs cannot avoid foreign objects

3 | MAJOR TYRE TYPES AND KEY ISSUES IN SELECTION

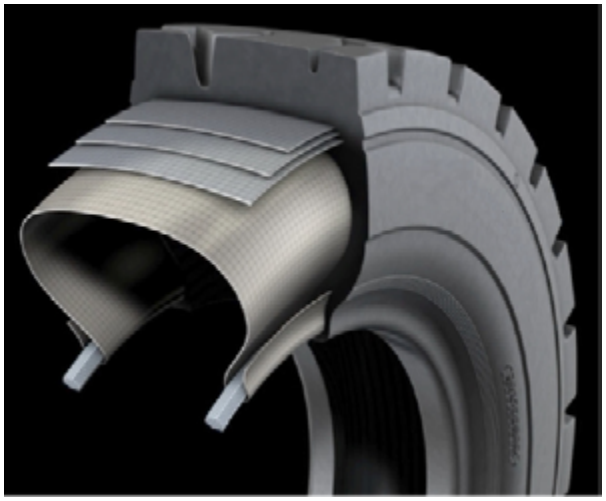
3.1 MAJOR TYRE TYPES

Handling or 'speciality' tyres are based on the main conventional tyre types - radial, crossply or solid (also known as super-elastic). However, they are manufactured to an industrial specification.

3.1.1 RADIAL

Radial tyres are commonly used for passenger cars, vans, light vehicles, trucks and 4x4 vehicles. Compared with other tyre types, their key characteristics are comfort, lower rolling resistance and lower energy consumption.

Radial tyre construction relies on a single metal reinforcement, which makes it more flexible and so more comfortable for drivers. This type of tyre may be found on terminal tractors and drayage vehicles. However these tyres will not stand up to the forces inherent in heavier operations.



Graphic: Radial Tyre

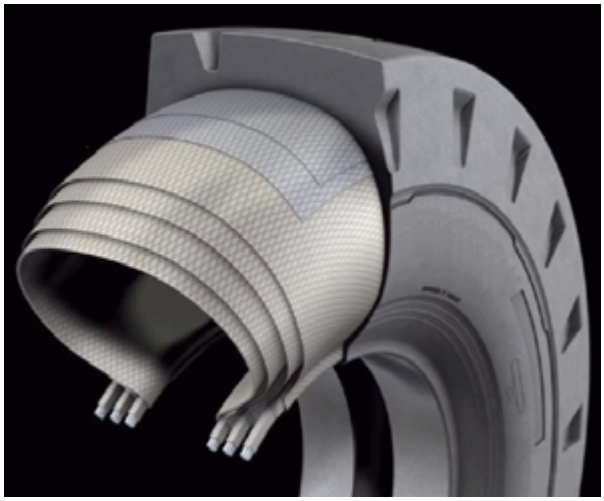
3.1.2 CROSSPLY

Crossply (bias) tyres are typically used on forklift trucks, airport vehicles, agricultural plant, construction equipment and, of course, in the port sector. Key characteristics include stability, resistance to sidewall impact and aging resistance.

Crossply tyres tend to be less flexible than radial tyres but as noted are more durable, due to a 40 ply nylon carcass and basic differences in construction. New technology is now reducing the number of layers required, making crossplies more comfortable for drivers.

In the port market for crossply tyres, special attention is paid to the stiffness of the side walls. In dual tyre operations this means there is less chance of 'kissing', which can lead to catastrophic failures.

Extra stiffness can also help in operations where lateral or tipping forces need to be resisted as much as possible, for example on reach stackers, empty container handlers, heavy-duty forklifts and straddle carriers.



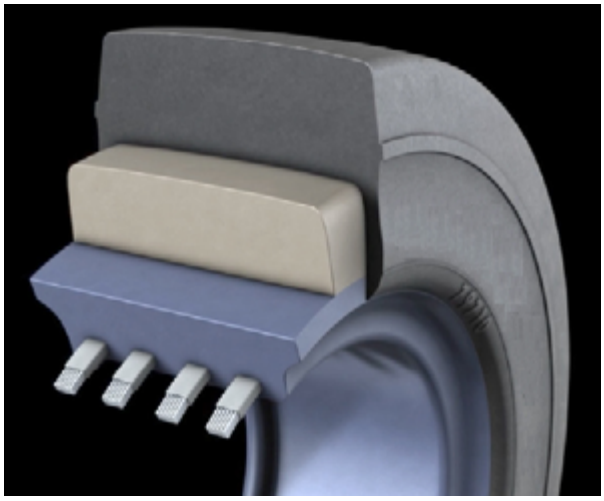
Graphic: Crossply/Bias Tyre

3.1.3 SOLID OR SUPER-ELASTIC

Super elastic tyres are 'solid' silica filled varieties, mostly used on forklifts, tractors and terminal trailers in the airport and marine port sectors, as well as other industry applications. They offer excellent stability, a long lifetime and are puncture and maintenance free.

This tyre type responds to the issue of rough ground and also the kind of scuffing and abrasion inherent in the

tight turns required of smaller mobile port equipment. While there is a general assumption that solid tyres are not comfortable, this kind of construction makes for good damping qualities on difficult terrain, and so can be useful for driver comfort.



Graphic: Super Elastic/Solid Tyre

3.1.4 TREADLESS

Treadless tyres give very good wear and less rolling resistance than treaded alternatives. Tread pattern alone does not control tyre grip and some operators prefer treadless designs to maximise contact with the surface.

In addition to the features of the pattern itself, tyre construction, the chemical composition of the tread, road surfaces, weather conditions, mechanical features of the vehicle, driving style and particularly speed all play a part in surface adhesion.

3.1.5 USED TYRES

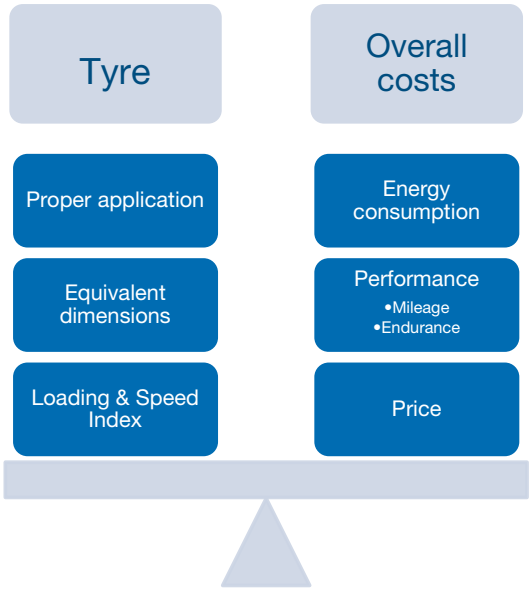
A word of caution: used tyres should *never* be fitted if their previous history is unknown.

3.2 KEY SELECTION CRITERIA

3.2.1 BASIC FUNCTIONS

Tyres perform four basic functions, each of which needs to be suitably considered in respect to the specific port equipment application.

- To contain a volume of pressurised air that will support the vehicle load
- To transmit traction and braking forces to the rolling surface
- To provide directional stability while changing or maintaining the direction of travel
- To supplement the vehicle suspension system, absorbing shocks from the rolling surface



Graphic: Tyre Selection - Balancing the Main Criteria

3.2.2 PROPERTIES

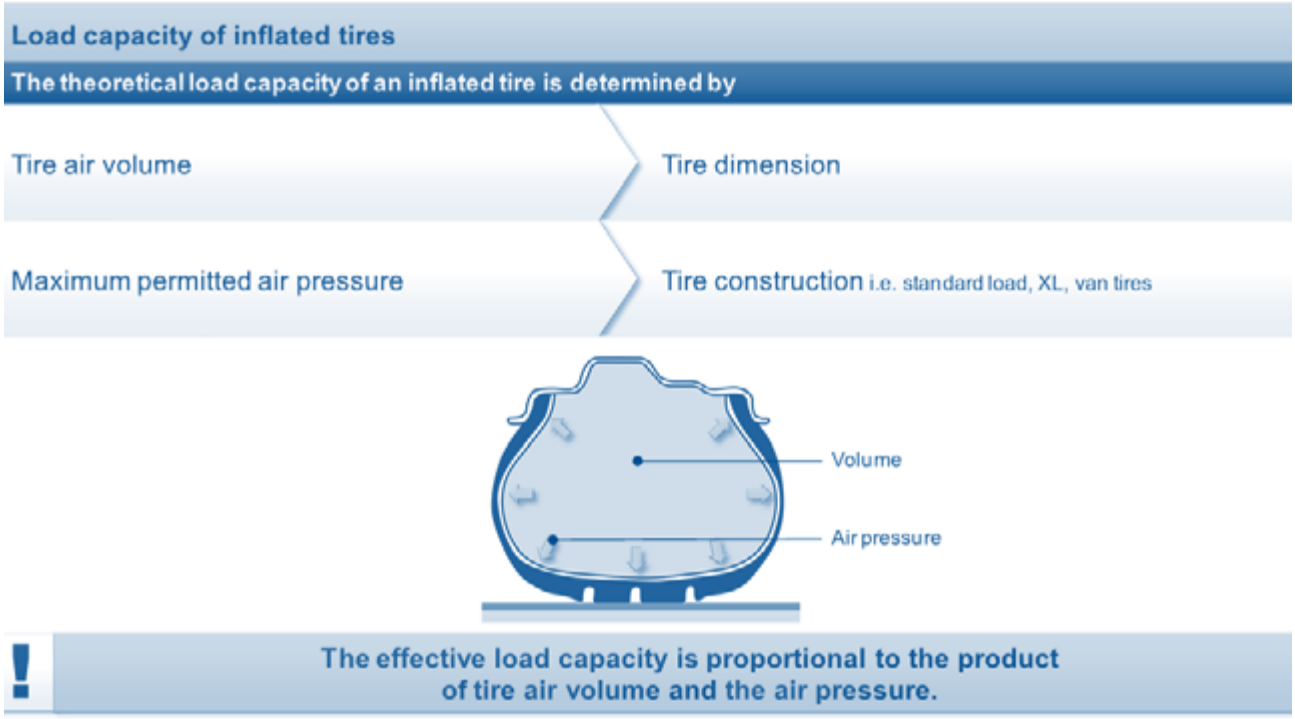
Speciality tyres need to feature a combination of properties, some of which overlap while others run counter to each other.

All of these elements will play some part in selection of tyres and should duly be considered and balanced out during the procurement process.

TYRE PROPERTIES

Economy	Comfort	Environmental aspects	Driving safety
Life expectancy/re-treadability	Handling ease	Life expectancy	Load capacity*
Puncture resistance	Noise emission	Noise emission	Durability/ puncture and sidewall resilience
Rolling resistance	Road bump absorption	Rolling resistance	Braking distance/ traction in various circumstances
Purchase price	Uniformity	Impact of manufacture	Stability/ lateral force resistance

*See separate graphic below



Graphic: Load Capacity of Inflated Tyres

4 | INSPECTION AND MAINTENANCE

4.1 MAJOR CAUSES OF TYRE DAMAGE

The main causes of tyre damage are summarised in the table below. Some of these relate directly to poor maintenance/servicing; all need to be factored into a regular preventative maintenance and inspection programme.

THE MAJOR CAUSES OF TYRE DAMAGE

Item	Key issues
Fitting and service	• Improper bead seating • Bead damage • Broken bead
Under inflation / overload	• Tyre damages • Valve / valve caps • Rim condition
Influences from suspension	• One -sided wear • Wear on both shoulders • Heel and toe wear • Shock absorber defect
Wrong application	• Permanent overloading • Trapped stones between twin tyres • Cut damages • Spot wear caused by locked wheel (worn patch) • Cuts caused by spinning, scuffed tread • Excessive lateral forces
Foreign impact	• Impact break • Cut • Nail hole • Hot braking drum • Ageing • Chemical influences

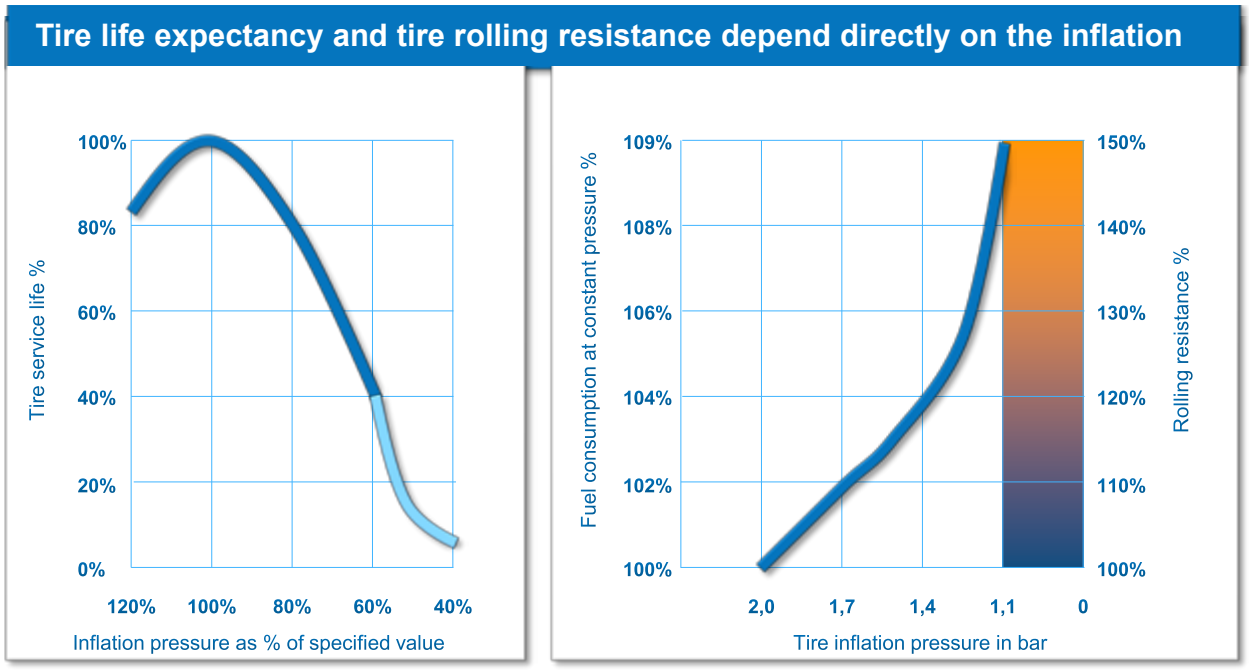
4.2 THE IMPORTANCE OF INFLATION PRESSURE

Inflation pressure has an extremely strong influence on tyre durability, fuel consumption, vehicle handling behaviour, tread wear and mileage, and traction and braking. Ensuring that tyres are inflated to the correct pressure should therefore be a top priority for fleet maintenance teams. Tyre pressure control must form part of a regular inspection programme.

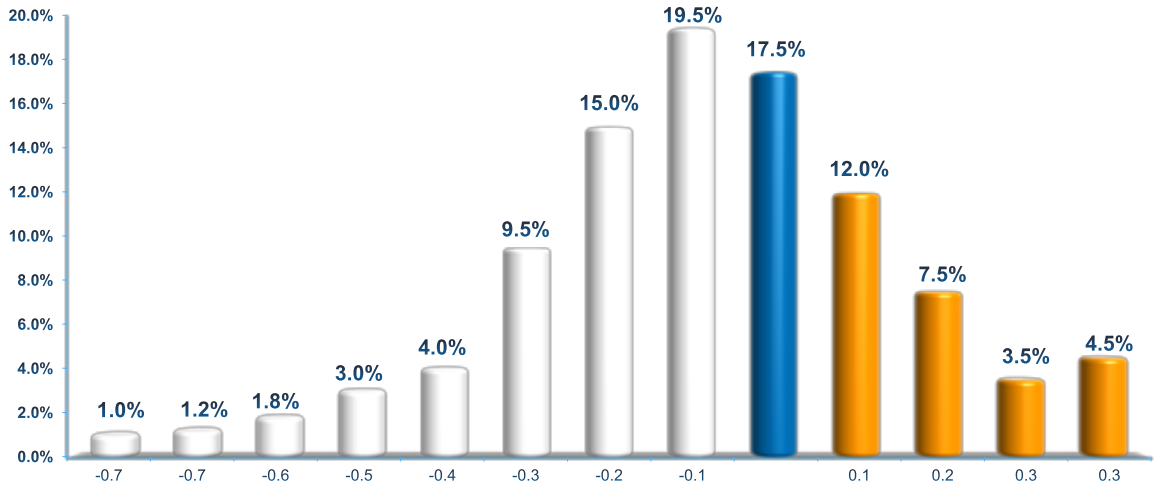
The majority of tyre damage is either directly due to, or aggravated by, incorrect inflation. Under-inflation is the main culprit. Driving with low pressure reduces stability and increases the build-up of heat, can cause irregular wear, internal damage and even lead to tyre break-up.

Inflation has a marked effect on expected tyre service life, which escalates sharply the more that a tyre deviates from the correct pressure.

At 80% of the correct inflation, tyre service life expectancy drops by 20%. At 60% of inflation, tyres lose around 40% of expected service life. It only takes a few percentage points less to dip even further down to 20% of the tyre's life expectancy.



Graphic: Tyre life expectancy and tyre rolling resistance and inflation comparison



Graphic: Tyre pressure maintenance

Running a tyre flat leaves bead chafing, imprints by the rim flange, signs of rubber break-up in the bead area and degradation of the inner liner due to heat caused by friction. There can also be abnormal wear on both sides of the shoulder edges, a broken carcass in the flexing zone (zipper-break) and localised spot wear.

Interestingly, over-inflation by 20% only shortens life by around 15% although it causes the tyre to be more susceptible to impact damage and in extreme cases may result in rim deformation or even a tyre burst.

Fuel economy again suffers with under-inflation. At 80% of the optimum pressure a vehicle may return only 75% of the ideal fuel efficiency. At less than this, for example with a tyre inflated to 60% of the correct air pressure, fuel efficiency plummets by 35%.

As for service life, over-inflation has less of an effect on fuel economy. A tyre with 120% pressure will run at 90% of idea fuel economy.

4.2.1 PRESSURE VARIATIONS AND CHECKS

While tyre manufacturers publish load and pressure tables, particular applications or vehicle stability might occasionally mean variations are recommended by the vehicle manufacturer. Needless to say, safety will be compromised by ignoring recommendations.

It is important to check the tyre pressures regularly, ideally every two weeks. The best time to do this is after the vehicle has been stopped and allowed to cool because pressures rise as tyres warm up in running (a point allowed for in the design).

Warm tyres therefore should not be either bled or adjusted back to the recommended (cold) values. Sealing valve caps should also be kept on the tyres.

4.2.2 TYRE PRESSURE MONITORING TECHNOLOGY

Since pressure is such a large factor in all aspects of port tyre maintenance, a much-needed aid to maintenance has come about through modern sensor technology.

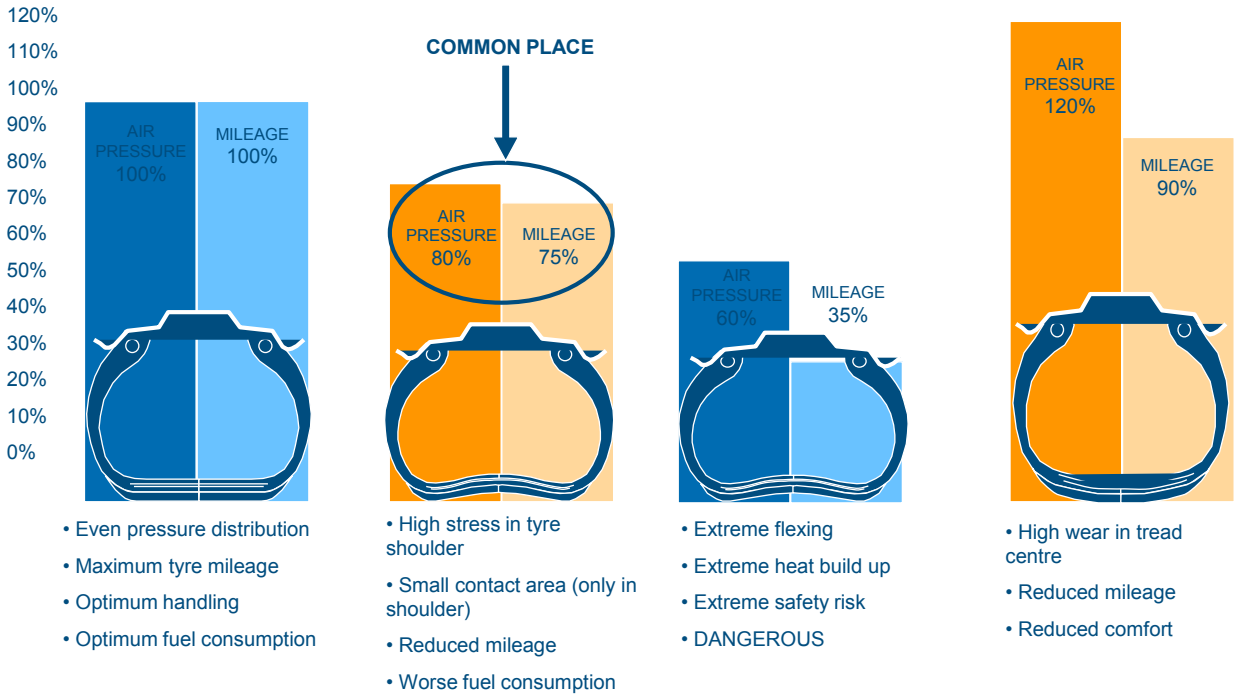
Tyre pressure monitoring systems (TPMS) use sensors incorporated into the tyre valve to check air pressure and temperature on an automatic basis. Some systems will display data in the cab and sound alarms for low or high pressure and temperatures. Others will transmit wirelessly to maintenance software. This allows maintenance and engineering staff to remotely track, manage and analyse the performance of individual tyres and machines.

As an added safety feature, some TPMS have the capability to restrict vehicle speed once a defect is detected, and display a 'return to workshop' message in the cab.

4.3 TYRE AND WHEEL INSPECTION

During an inspection, both the tyre tread and sidewall need to be checked for evidence of abnormal wear, cracks, cuts, abrasions, localised deformities and foreign bodies such as trapped stones and nails. Special attention should be paid to the areas between twin tyres.

The bead/rim flange should also be inspected for



Graphic: General considerations in tyre pressure effect on tyre life

signs of deformity, chafing, damage or misfitting. Any peeling of layers on the outer bead area is fairly obvious and easy to spot. However, this kind of damage can also happen on the inner liner, resulting in decreasing air pressure. The inner liner must therefore also be checked as standard during an inspection.

Particular attention also needs to be paid to the condition of the inside tyre of twin sets, as these can be subject to a higher proportion of the wear.

If damage such as a blister, rupture, or cut exposing the casing is visible on a tyre, or if it has suffered heavy impact (for example against a kerb), it must be removed immediately and examined by a specialist - even though there may be no visible evidence. Anti-puncture products can simply mask secondary damage and preclude internal examination.

Wheels should be checked regularly, and any sharp edges on the rims should be removed in order to avoid tyre damage. However, distorted rim flanges and discs need to be replaced.

In order to avoid tension crack corrosion on the wheels, as well as tyre damage, the anticorrosive protection on the wheel must be fully checked and renewed as necessary, even on the tyre side of the rim and rings. There is an exception: rims for conductive tyres need exposed metal or have some kind of surface treatment to encourage conductivity between tyre and rim.

Periodically, tyres need to be rotated, balanced and aligned to ensure even tread wear. The best way to avoid a tyre being out of balance is to have it rebalanced every time it comes off the machine.

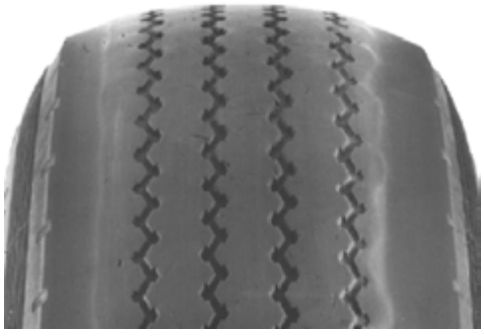
Graphic: Bead chafing from rim flange

If the vehicle is pulling to one side or shuddering, it could be due to misaligned or out of balance tyres: both also cause tread to wear out unevenly. Rotating the tyres will help lifetime, fuel consumption and traction.

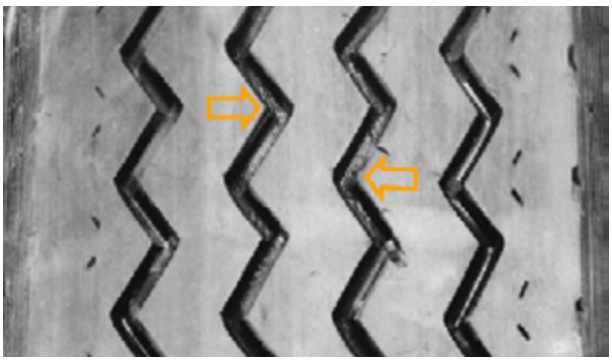
Exposed steel cords can rust as dirt and moisture take hold. This may render the tyre unsuitable for remoulding and in the final stages this can even lead to premature tyre failure.

There are also factors to be borne in mind when the tyre is not on the vehicle. Tyres must be stored in dry, clean conditions free from exposure to sunlight or strong artificial light, extremes of temperature, ozone (electrical machines) and hydrocarbons. They should not be stored in the same position for more than 90 days. When stored fitted on rims, inflation pressure should be reduced.

Graphic: Abnormal wear



Graphic: Exposed steel cords



4.4 TYRE REPAIR AND RETREADING

Firstly, as always, tyres should be deflated before removal of the wheel assembly from the vehicle. If a repair to a tyre is possible, it must be carried out soon after the damage occurs in order to avoid further deterioration of the tyre structure.

Cracked rims or discs cannot be welded under any circumstances because the welding will simply crack open again after a very short running time. Further, damaged or distorted wheels, or wheels with cracked or deformed stud-hole seatings, must not be repaired and put back in service.

4.4.1 PUNCTURES

Punctures are a common issue. Ports and terminals are not clean sites, with all sorts of detritus commonly found on the ground. So, one important factor is not just investing in technology, but in cleaning operations.

4.5 TYRE OR WHEEL REMOVAL AND FITTING

Manufacturers' fitting and removal recommendations must be incorporated into a safe system of work including a a thorough training regime. Supervision is needed to ensure that these procedures are correctly followed.

Removal and fitting of tyres must be entrusted only to trained crew. Inexpert fitting may lead to personal injury and concealed damage to tyres and wheels. In case of doubt, consult the rim/wheel manufacturer.

It is essential to make sure that the tyre is completely deflated by unscrewing and removing the valve core, which then should be checked for dirt etc and cleaned.

4.5.1 FITTING

Use the appropriate presses and accessories. Only approved proprietary lubricants should be applied to the beads. If this recommendation is not followed, bead damage or fracture can occur during fitting. Hydrocarbons must not be used as these degrade the rubber.

Ensure that the rim is correct for the tyre size, and that tubeless tyres are fitted on airtight rims. Rim components should not be modified, nor should components from different manufacturers be mixed.

Remove all contamination (dirt, grease, rust, fitting lubricant, etc) and inspect the tyre and rim carefully.

Check that the tyres and inner tubes are free from damage and take particular care that no foreign matter remains inside the tyre or between the tyre bead and the rim bead seat.

Graphic: Foreign material penetration

Always fit a new inner tube and flap, or a new valve or valve grommet in the case of tubeless tyres, and a new seal for tubeless tyres.

Carefully check the condition of the valve hole. The edge of the valve hole on the tyre side of the rim must be rounded and smooth. On the weather side, the edge must be free from any burrs that can damage the valve stem.

In order to avoid damage to the inner tube or flap, ensure that the valve is sitting correctly in the valve hole. The use of valve extension pieces is advisable for valves on the inner tyre of twin assemblies where access is more difficult.

Re-inflation should be conducted in two steps making certain that the beads are seated correctly on the rim:

1. Stop inflating the tyre at 150kPa
2. Inspect the tyre: any deformation or blisters require examination by a specialist

The tyre should then be placed in a vertical position in a safety cage and inflated to the specified pressure.

4.5.2 MULTI-PIECE ASSEMBLIES

There are certain risks associated with the maintenance

of multi-piece split rim wheel assemblies.

When multi-piece rim wheels are inflated they are under great pressure – this is what holds the components of the wheel together.

An uncontrolled release of air from the tyre will cause the rim wheel components to separate in an extremely violent way. Unfortunately, such incidents often result in the death of the maintenance worker.

The risks can also be heightened by corroded, dirty, damaged or mismatched rim parts, over-inflating tyres, or, on some designs, removing the nut which holds the wheel rim together. Checks need to be carried out that the different components are correct and compatible.

It cannot be over-emphasised that the tyre must be depressurised before maintenance commences. Further, as the danger encompasses the period prior to starting work, the operator must avoid standing in the path of loose flange components which could spring off.

Partial re-inflation should not be above 100kPa, just enabling the detachable flange to be located correctly against the lock ring. Ensure seating in a safety cage or portable safety device. If neither are available place the wheel against a wall with the detachable rim parts facing inward to give the workers some protection in case of an incident.

The airline between the valve and the pressure gauge should be long enough to enable the fitter to stand clear of any potential danger.

4.5.3 DIVIDED WHEELS

Divided wheels may have rim portions of unequal diameter which, when securely fastened together, combine to form a rim having two fixed flanges.

Designs should ideally only allow access to the whole assembly on the vehicle, the connecting devices only being accessible after dismounting. If this is not the case, these connections must be clearly identified.

The demounting of the wheel from the vehicle and of the tyre from wheel must be carried out in the following sequence:

1. Complete deflation of the tyre (to have no pressure on the rim)
2. Demount the wheel from the vehicle
3. Disconnect the two wheel parts and demount the tyre

When mounting, the tyre must be only inflated after the connecting devices of the wheels are secure.

4.5.4 MIXED FITTINGS

It is generally best to fit complete sets of tyres. However, given that this is not always possible, certain precautions must be observed:

Firstly, the tyres on a given axle must be of the same size and structure (radial, crossply etc). They should also be of a similar category of use and have approximately the same degree of tread wear. The mounting and matching of twin tyres requires the difference of pattern depth and tyre radius to be kept below 4.0mm.

At no time should tyres of different construction be fitted on the same axle. However, mixed fittings (for example, radial tyres at the front and diagonal tyres at the rear) should be fine provided the stability has been properly checked.

4.5.4 ETRTO RECOMMENDATIONS

The European Tyre and Rim Technical Organisation (ETRTO) has produced a detailed set of recommendations to assist in the safe selection and maintenance of tyres.

The ETRTO Recommendations, last updated in March 2014, include specific sections on pneumatic and solid industrial and lift truck tyres, covering:

- General issues
- Care and maintenance
- Fitting and removal
- Inspection
- Replacement tyre selection

For more information and to download the Recommendations please visit www.etrto.org

ABOUT THE AUTHORS & PEMA

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Founded in late 2004, the mission of PEMA is to provide a forum and public voice for the global port equipment and technology sectors, reflecting their critical role in enabling safe, secure, sustainable and productive ports, and thereby supporting world maritime trade.

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