

Tyre damage: Causes and avoidance

Car tyres 2013 - 14



Imprint

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Introduction

This brochure provides advice for all those dealing with tyre damage in a professional capacity. It documents the tyre damage occurring most frequently according to our extensive experience.

Damage to passenger car tyres and **the causes of this damage are explained** by means of precise descriptions and photographs. Last but not least, recommendations are given as to how such **damage can be avoided**.

This brochure is intended primarily for those retail tyre specialists called upon to evaluate their customers' tyre damage.

When a tyre fails, the motorist wants to know as soon as possible why this happened and whether it was due to defective material, faulty workmanship or on the other hand, it was due to misuse.

This brochure is intended to help the tyre specialist answer these questions quickly and competently.

A car's four tyres are the vehicle's sole contact with the road. Many motorists tend to forget this, to the detriment of their own safety, neglecting to **attend to the necessary care and maintenance** of the tyres.

Improper use can result in premature tyre wear or even tyre failure. While poor mileage is only an economic problem, **tyre damage can prove very dangerous** and result in personal or property injury.

Statistically, tyre breakdowns are rare events these days. The average driver experiences serious tyre problems only once every ten years or once every 150.000 kilometres (95.000 miles).



This bears witness to the high technical standard achieved in the meantime both in the tyre industry (manufacturing quality) and in the retail tyre trade (service quality).

Damaged tyres can be the cause not only of breakdowns, but also serious accidents. It is our experience that inadequate care and servicing are often the cause of the kind of poor tyre condition which can lead to tyre failure.

This means that evaluating and processing damage claims is not the whole story. It is also necessary to advise the consumer. This brochure provides help in this regard as well.

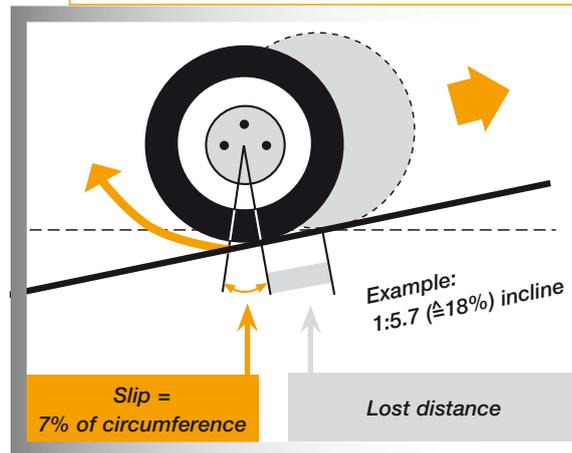
Wear is unavoidable...

It may sound like a tyre maker's wishful thinking, but tyre wear is nonetheless a physical fact.

When the vehicle is moving, the tread of each of the vehicle's tyres is constantly rubbing against the road surface. This is evident from the tyres' gradually diminishing tread depth. The fact that a tyre wears - normally in slow and uniform fashion - is thus inevitable and even necessary. This is because the laws of physics require that there be slip if force is to be transmitted to the road, regardless of whether the force involved be circumferential - as in the case of acceleration or braking - or lateral - as occurs in cornering. Slip designates the relative movement between the road and the tyre that occurs when force is transmitted. Slip means that the vehicle speed

is greater or smaller than the wheel's circumferential speed. In other words, the distance the vehicle covers is longer or shorter than the rolling circumference of the tyre.

*Slip causes wear
Aggressive driving increases the degree of slip.*



...but subject to influence



The degree of wear, and thus the mileage performance of a passenger car tyre, depends, among other things, on the degree of slip. While slip, as such, is a necessary occurrence during driving, **the degree of slip is greatly dependent on the motorist's driving style.** The increase in tread wear is related to the amount of slip. Twice as much slip translates into four times as much wear and therefore a quarter of the tyre mileage performance.

In the case of gentle, brisk acceleration on a dry road surface, slip values of up to 2% are attained. Values as high as 20% are possible if the car is driven to its limit. Wear varies by a factor of ten depending on whether the motorist's driving style is normal or erratic.

Depending on the driving style - whether economical or high performance - comparable tyres can yield mileage of anywhere between 5,000 and 40,000 km (3,000 and 25,000 miles).

Furthermore, the severity of wear depends essentially on the speed at which the vehicle is moving, on the surface condition of the road and on the wheel load. The following examples may serve to clarify this:

If a vehicle with locked front wheels is brought to a complete standstill on a dry road, the tyre's postcard-sized contact patch will show roughly the following amounts of **rubber abrasion**:

*up to 2.0 mm at 57 km/h (35 mph) (or a braking distance of 23.8 m)
up to 3.3 mm at 75 km/h (47 mph) (or a braking distance of 41.8 m)
up to 4.8 mm at 92 km/h (57 mph) (or a braking distance of 71.6 m)*

Causes of nonuniform wear patterns

Every type of nonuniform wear shortens the potential mileage performance of a tyre. The causes of such premature wear are normally evident on the basis of the characteristics of the abnormal wear pattern displayed by the tread.

Impact of the chassis on tyre wear

Alignment:

If due to mis-alignment, the tyres do not run parallel to each other, then one shoulder of tread gets scrubbed off, resulting in one-sided wear.

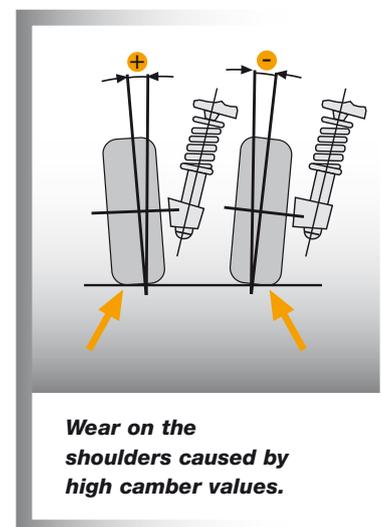
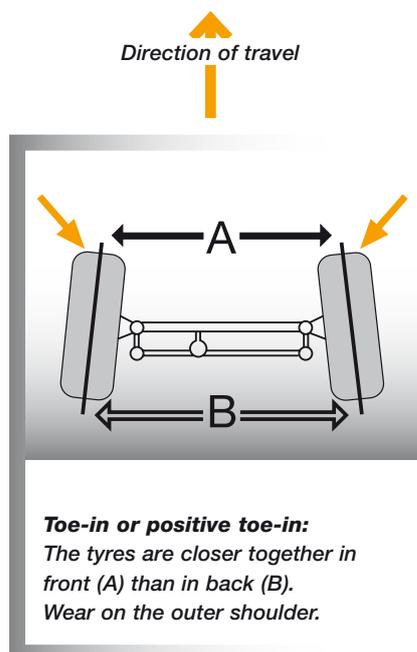
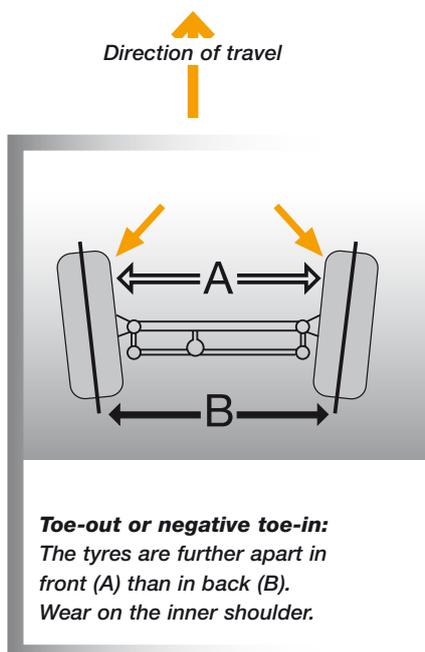
This mis-alignment is usually recognisable from the fact that the tread pattern ribs show signs of "feathering" where the edges have been scrubbed away (Sipes).

Fast driving on winding roads leads to increased wear, especially on the outer shoulder of the tyre (the one away from the vehicle).

Front - and/or rear-axle toe-in – a means by which some vehicle manufacturers optimise the handling characteristics of their vehicles - can also cause one-sided wear.

Camber:

One-sided wear is also caused by high camber values: positive camber (+) leads to wear on the outer shoulder, negative camber (-) to wear on the inner shoulder.



One-sided wear

The most frequent cause of one-sided wear is a **wheel geometry in deviation of specifications**.

These deviations develop over time and are the price the driver pays for bad driving habits, for example, kerb mounting.

Tip If a vehicle's wheels are misaligned, the wheels must be aligned and the deviation corrected.

Lowering a vehicle in conjunction with low-profile tyres can also negatively affect wheel alignment. The modified lever arms (e.g. less rim offset after retrofitting) encourage a tendency for the alignment of the wheels to deviate during driving from the specified data.

This might go unnoticed as all wheel alignment values are still found to be within tolerance limits when measured statically on the axle measurement bench. The result may be an increase in nonuniform wear.

The manufacturer's alignment data applies to vehicles as delivered and may not necessarily apply to customised vehicles.



Increased, one-sided wear due to "slip". It is frequently encountered in connection with a worn tread surface. This is also often seen together with burrs along block edges up to worn tyre shoulders.

Wear in the tread centre

This wear pattern is found on powered wheels of highly motorised vehicles. Even today's mid-range cars have **modern engines generating high levels of torque** and capable of producing high degrees of slip.

These high torque levels, during strong acceleration or in stop-start urban traffic, or when accelerating away from traffic lights, can quickly increase wear of the tread centre.

For safety reasons, the tyre inflation pressure must not be allowed to drop below the vehicle manufacturer's recommendation. (See also the Continental inflation pressure table.)

Tip By rotating the wheels from the powered to the nonpowered axle before it is too late, it is possible to obtain a largely uniform pattern of wear. Always observe the vehicle manufacturer's recommendations.



Example of tyre wear pattern on powered axle of a powerful car: pronounced wear is visible in the tread centre.

Diagonal spot wear

Diagonal spot wear runs at an angle of about 45° to the circumferential plane. It usually occurs on the circumference of the tyre only once, although multiple instances are also known.

Vehicles affected are usually front wheel drive.

Spot wear is restricted more or less to nonpowered wheel positions, especially the rear left position. Some vehicle models are particularly susceptible to spot wear, while others are not affected at all. The effect is aggravated by high toe-in values (see page 6).

This is because the toed-in tyre rolls at a slip angle, even when the vehicle is travelling straight ahead. The result is diagonal warping

Tip To avoid wear of this nature, the toe-in values should lie at the lower end of the tolerance range specified by the vehicle manufacturer. The tyres should be properly inflated. At the first sign of spot wear, the wheels concerned should be transferred to the powered axle. Vehicle manufacturer's specifications must be observed.

in the tyre/road contact zone. Toe-in values at the lower end of the manufacturer's tolerance range are best as far as wear is concerned.

In the area with the most severe diagonal spot wear, certain structural parts of the tyre often touch.

Underinflation or shock absorbers that do not function properly aggravate this type of wear.



Diagonal spot wear

Saw-tooth wear

“Saw-tooth” wear is a wear pattern caused under normal usage with normal suspension settings. This is the outwardly visible (and audible) manifestation of various distortional forces at work on the tread.

To explain this, it is better to first say something about “tread design”.

Tread grooves and sipes – a source of noise – are absolutely essential in ensuring safety on wet and flooded roads. In the case of low-profile tyres in particular, a higher percentage of tread void is necessary to take up the water and to improve the protection against aquaplaning.

Cross-grooves for water drainage form “free-standing blocks” in the shoulder area. These shoulder blocks can wear to leave the “saw-tooth” pattern as a result of rolling mechanisms under certain operating conditions.

These operating conditions include:

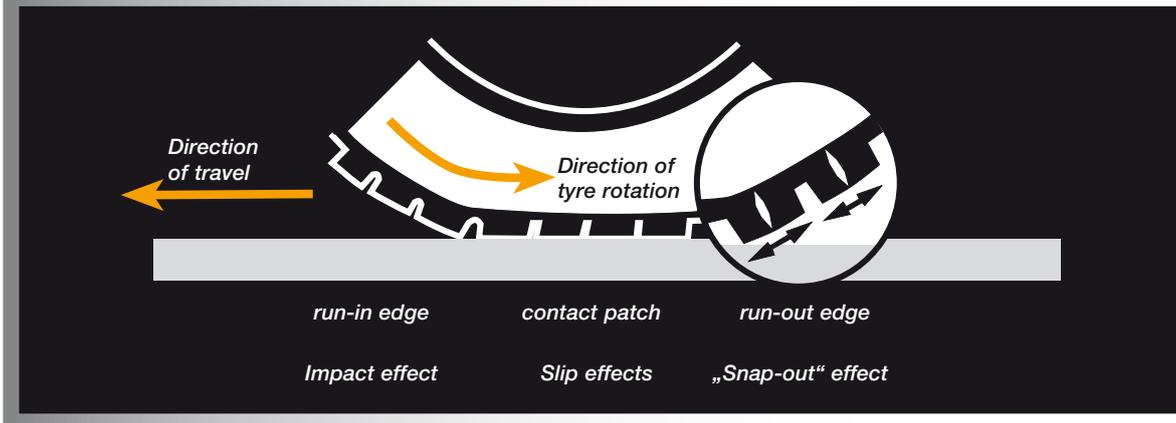
- Long, straight journeys at constant speed
- Moderate driving style
- Suspension geometry (alignment/camber).

As the tyre rolls along the road, the freestanding blocks deform as they near the tyre's contact patch. They are compressed as they come into contact with the road. As they lose road contact they "rub" the surface while snapping back into their original shape.

The result is higher wear on the block run-out edge.

This wear pattern is more likely to occur on nonpowered wheel positions.

Creation of "saw-tooth wear"



Tyres with large blocks or laterally open grooves are susceptible to stepped wear, particularly in non-powered wheel positions. The blocks exhibit more pronounced wear on the rear edge (relative to the direction of tyre rotation) than on the front (leading) edge, giving the blocks a characteristic saw-tooth wear pattern when viewed from the side.

A minor amount of "saw-tooth" pattern wear is normal and has no discernible effects on comfort.

More conspicuous wear of this kind points to specific operating conditions (improper inflation, excessive toe-in, low-wear applications).

Tip: In order to gain even tyre wear, the position of the tyres on the car should be changed at regular intervals (unless otherwise recommended by the vehicle manufacturer). The position of the tyres should be changed in good time, at the latest when changing summer/winter tyres.

Braking flat spots

Braking flat spots are the **result of full braking** with locked wheels, causing the tyre to "lay rubber".

There is no tread compound which can avoid the severe wear caused by extreme braking manoeuvres.



Severe wear due to full braking (without ABS).

Brakes can lock briefly even on vehicles equipped with ABS (antilock brake system), causing minor flat spotting.

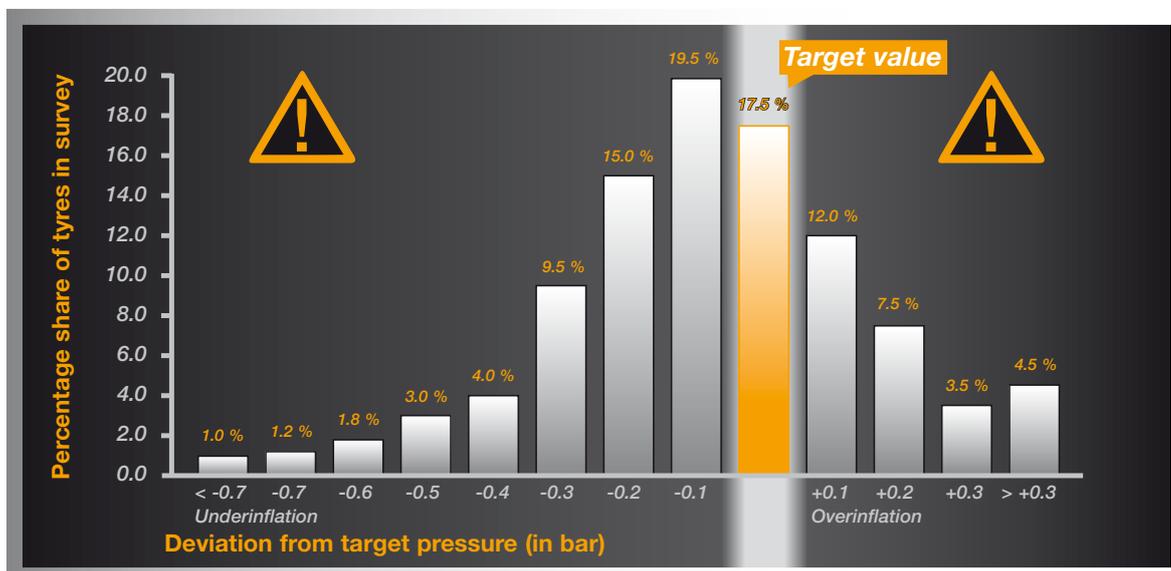


Tip Extreme wear of this kind is responsible for a certain amount of vehicle vibration. This problem cannot be eliminated by balancing the wheels. The tyre can no longer be driven and must be replaced.

Tyre damage due to incorrect inflation pressure

Correct inflation is crucially important to the service life, economy, handling characteristics and, above all, the safety of a tyre. The optimum inflation pressure for a specific tyre is jointly defined for each vehicle type by the tyre and vehicle manufacturers. It varies depending on load and operating conditions.

The recommended inflation pressure values are given in the vehicle operating manual or marked somewhere on the vehicle itself, e.g. on the tank flap (see also the Continental inflation pressure table).



Many car drivers drive with wrong tyre inflation pressure

(source: Continental study)

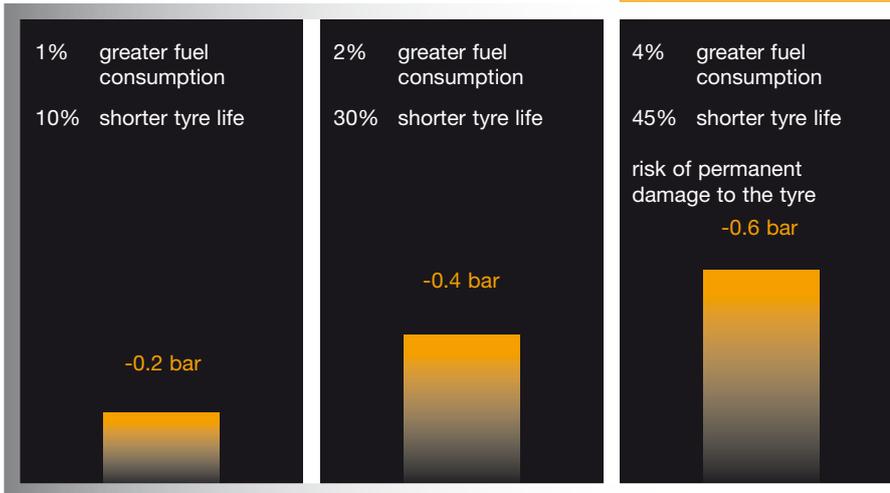
Once the tyres are fitted to the vehicle, it is the responsibility of the driver to regularly check and adjust the inflation pressure.

Repeated studies carried out by various tyre manufacturers and independent institutes have

brought to light that more than half of all motorists drive on underinflated tyres.

Insufficient inflation pressure is one of the most frequent causes of accidents.

Risks of underinflation



Driving with too low inflation pressure

Driving on underinflated tyres has a negative impact on:

- steering response
- directional stability
- driving safety (tyres can separate from the rim)
- cost-efficiency (higher rolling resistance, lower mileage)
- durability.

The lateral tracking forces which the tyre can transmit to the road surface are reduced depending upon the inflation pressure.

When making a quick lane change, for instance, the motorist may lose control of the vehicle if the tyres are underinflated. Low tyre pressures can reduce the safety when negotiating corners. The tyre bead may be torn away from the rim and slip from the rim flange down into the well base. The result is a sudden loss of air pressure in the tyre.

If the inflation pressure is not adjusted to load, the result is increased flexing and higher energy consumption (fuel consumption).

Greater flexing causes the tyre to heat up, which can result in structural damage in the tyre and even to tyre failure.

It is clear from these facts that proper inflation is crucial. Motorists should be alerted to this in the interest of their own personal safety and that of their passengers.

Drivers should also be informed as to the correct way of checking inflation pressure. The ideal is an integrated inflation pressure monitoring system, even though this cannot fully replace regular manual checking of inflation pressure. In all cases, the inflation pressure **should be checked at regular two-week intervals**. The inflation pressure must be checked when the tyre is **cold** (not after it has been warmed up by use).

Driving with too low inflation pressure

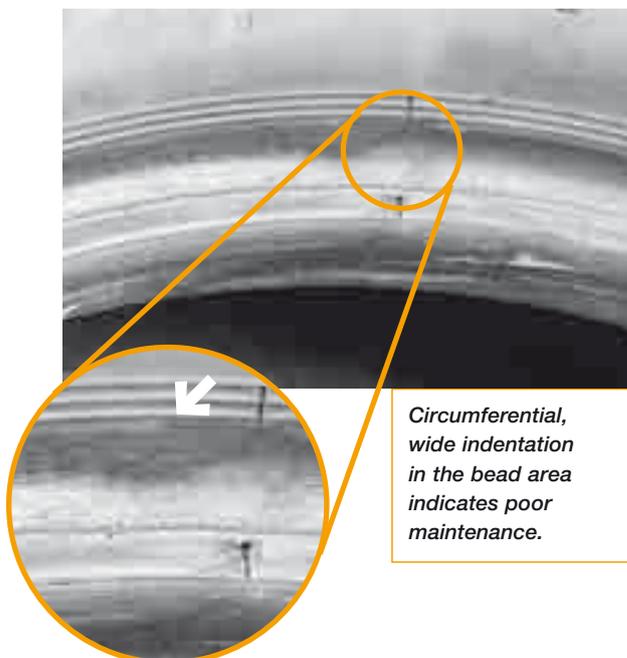
The spare tyre should also be remembered when checking the inflation pressure regularly.

The valve caps should always be screwed in place to prevent dirt contaminating the valve.

Even tyres that are inflated with tyre gas need to be checked on a regular basis, since tyre or valve damage on such tyres can also result in gradual loss of pressure.

The tyre specialist's attention is also drawn to the information on this subject given in our Tyre Pressure charts and Fitment Guide Booklets.

The tyre shown here was occasionally driven with inflation pressure insufficient for the load. Noticeable signs of this are circumferential, wide tracks in the bead area, where the tyre chafed against the rim flange, and shoulder wear on both sides. Discolouring or "compression wrinkling" of the inner liner at the level of the sidewall, indicate that the tyre has been driven in an underinflated state.



Circumferential, wide indentation in the bead area indicates poor maintenance.

Tip *Damage of this kind can be avoided if the tyres are regularly checked to ensure that they are correctly inflated and if care is taken not to exceed the tyre's specified load capacity.*

Driving on an improperly inflated tyre can inflict internal structural damage to the tyre. This can result in a decrease of the tyre's durability, and even cause rapid deflation. Concealed tyre damage is not eliminated by subsequently adjusting the inflation pressure. Damaged tyres do not "heal" themselves.

The tyre's contact patch is deformed when rolling. This can result in high shearing between different components. If a tyre is improperly serviced and driven in an underinflated state and/or with excessive load, it heats up beyond the critical temperature range, resulting in partial separation of plies (partial tyre disintegration).

Damage of this type usually develops over a longer period of time. If the already damaged tyre is then subjected to a high level of stress, parts of the tyre may detach due to the enormous centrifugal forces at work on the tyre at high speeds.



Parts of the tyre have torn off as a result of poor maintenance.

Driving with decreasing inflation pressure

A gradual decrease in tyre inflation pressure is an especially difficult phenomenon. It can easily escape the attention of even well-versed motorists. Especially at high speeds - on motorways, for instance - the combination of centrifugal force and residual pressure may give the impression that the tyre is sufficiently inflated.

With the gradual reduction in inflation pressure and the consequent increase in flexing, the tyre material is subjected to excessive mechanical and thermal stresses, which can ultimately result in the separation of the tyre's structural components and rubber compounds. The final result is most often a total breakdown of the tyre.

When this happens the tyre is usually severely damaged; certain structural components may even be missing. In this state, it is often no longer possible to pinpoint the exact cause for the gradual loss of pressure.

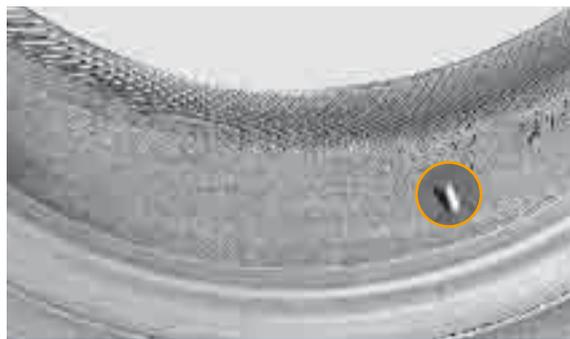
The **loss is most frequently attributed** to minor external **injuries**, a damaged **valve** or a leaky **rim** as a result of corrosion or other damage.

Tip Damaged valves and rims must be replaced with new ones. The valve should be replaced each time a tyre is fitted. If a direct tyre pressure monitoring system is fitted, the sealing-ring on the sensor should also be renewed. Always observe the specifications of the system manufacturer, e.g. Beru or Schrader.

If any repair work is required it must be carried out by a qualified repair shop, which bears the full responsibility for proper execution of the job.



Major heat build-up in the tyre due to driving in an underinflated state led to separation of structural components and to melt-down of the rubber.



Circumferential discolorations of the sidewall in the flexing zone are indications of extended trips with falling inflation pressure or low inflation pressure.

○ Nail puncture

Damage due to external influences

Other types of damage occur to tyres as a result of external influences. This can happen for example when driving unintentionally or quickly over obstacles.

And a tyre can already be damaged if it has been mounted incorrectly.

Impact break

An impact break involves damage to the carcass (the casing of the tyre) inflicted when the tyre is in contact with certain obstacles.

Usually an externally visible bulge on the sidewall of the tyre indicates that cords have been destroyed inside the carcass. If such damage is ignored there is the risk of tyre failure at some time in the future, usually delamination of the tread and/or plies or disintegration of the tyre flank.

Damage of this kind is typically caused by driving over objects – like kerbs or speed bumps – at excessive speed and/or at the wrong angle. This overstresses the carcass and can cause individual cords to break.

The extent of the damage depends on the speed and angle of impact and on the size of the obstacle. Motorists are usually able to prevent this type of damage themselves.

It is inevitable only in very exceptional cases - when an obstacle suddenly appears in front of a vehicle, for example.



Damage seen from outside.



Tip Kerbs and similar obstacles should only be driven over at an obtuse angle and at appropriately slow speed.



The carcass was jammed up against the rim flange as a result of a strong impact and has split in the area of contact. (Damage seen from inside the tyre)

Fitting damage

Tyres can also be damaged even when not in use, for example due to incorrect mounting on the rim.

The bead might be damaged while the tyre is being fitted or removed using a tyre fitting machine.

The bead base, in particular, can be cut circumferentially and/or crushed down to the bead wire.

Damage of this type can occur when tucking in the bead in the following situations:

- ▶ the opposing bead section is not completely inserted in the drop centre of the rim;
- ▶ the mounting head on the machine is not properly adjusted or the mounting shoe is worn (sharp-edged);
- ▶ the edge of the mounting roller rolls off the base of the bead.

In the damaged area, the guide roller frequently leaves marks where it has made contact with the tyre. The likelihood of damage occurring increases if the guide rollers used have developed sharp-edges as a result of wear.

Both beads and the rim shoulders must always be sufficiently lubricated before fitting. Undetected fitting damage can result in the tyre failure at a later date.



Bead damage caused during fitting.

Fitting SSR tyres*:

For tips on fitting SSR tyres, please refer to our web pages: www.conti-ssr.co.uk

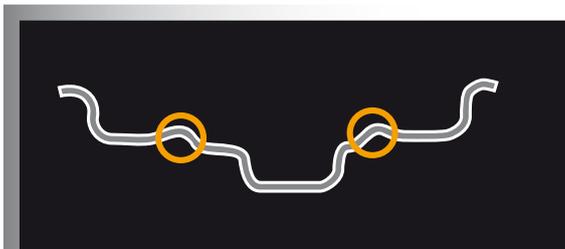
Or contact the Continental Customer Service.

**Self-Supporting Run-flat tyres*

Bead wire breaks

Safety rims are mandatory for tubeless radial car tyres. These rims usually have a circumferential hump on at least one of the rim's shoulders.

The hump is intended to ensure that the bead remains firmly seated on the shoulder of the rim.



Rim profile with round hump on both sides (H2).

Tip Always use undamaged, clean and rust-free rims of the correct size which are neither deformed nor worn.

Always use tyre fitting lubricant to allow the bead to slide easily over the humps.

The "pop" pressure should never exceed 3.3 bar before both beads are evenly seated on the rim flange.

When the tyre is inflated in the process of mounting, part of the bead may get caught on the hump. In this case there is a danger of the bead excessively expanding if the tyre is overinflated and of some or all of its steel wires breaking. The pressure exerted to get the bead over the hump **must not**, for this reason, **exceed 3.3 bar**. If the tyre cannot be properly mounted at this pressure, the fitting process must be stopped. The rim flange and tyre beads should be checked to ensure that sufficient fitting lubricant has been applied. If required, additional fitting lubricant should be used. The tyres can now be fit again.

Usually there is no external indication of a bead break.



Ruptured bead as a result of tension during inflation of a tyre.

Sidewall indentations – not a defect

The sidewall of a tyre is not always completely flat and even; there are sometimes bumps, and indentations, which may require a more detailed inspection to decide the cause.

Such indentations are **harmless and are not detrimental either to safety or to driving characteristics**. They are only a visual problem.

Indentations in the tyre are caused in the same way as if you were to tie a string around an inflated balloon or a soft fruit and then gently tighten the string.

In the case of the tyre the string is invisible on the inside, hidden by the rubber. The flanks of a tyre include embedded carcass threads which give the tyre its strength and are also vital for transferring steering and braking forces.

When a tyre is manufactured - or rather when constructing the carcass, to which the steel belt and the tread are then attached - there is always at least one overlapping seam.

It is this seam which is sometimes visible as an indentation after the tyre is fitted and inflated with air – although usually they are more or less invisible.



Indentation at the carcass ply overlap seam.



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