Function of the Tyre

Tyre contact area (footprint)

The tyre contact area or footprint is the only area of contact between the vehicle and the road. It depends on the type of the tyre (normal/wide tyres), the tyre tread, the inflation pressure, the speed, the load and other factors.

Too high a tyre inflation pressure reduces the footprint and thus results in poorer handling characteristics.

At high speeds the footprint is reduced by the high levels of centrifugal force which act upon the tyre.

Aquaplaning can reduce the size of the footprint to 0; in this case, the wheel control characteristics are totally lost.

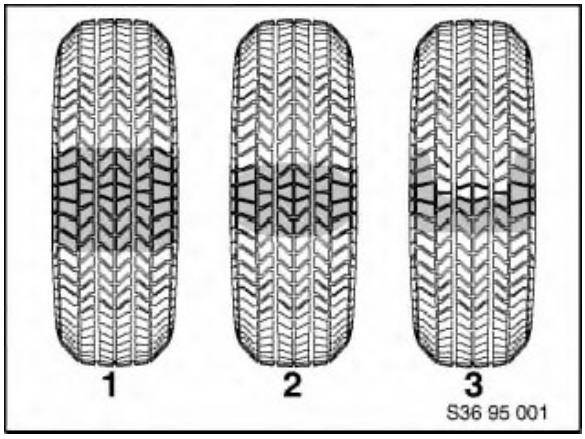

Figure 1: Footprints

1. Footprint with correct inflation pressure and at normal speed
2. Footprint with high inflation pressure or at high speed
3. Reduction in footprint due to aquaplaning

Forces

Various forces act on the tyres:

- Acting perpendicular to the roadway is the weight of the vehicle; it presses the tyre on to the ground and generates the vertical tyre force, also known as normal force (4). The tyre generates the radial force as a counterforce. This force develops through the elastic deformation of the tyre, through the inflation pressure and the centrifugal force that exists when the tyre is rotating.
- The force acting in the direction of travel is the tractive force (2). Acting against the tractive force - in addition to the air resistance - is the rolling resistance of the tyres.
- Likewise acting in the direction of travel, but with the opposite sign, is the braking force (1).
- Lateral forces arise when there is a side wind and when cornering (3). Under the action of these lateral forces, the shape of the tyre is deformed and as a result the tyre develops the cornering force which acts against the lateral forces.

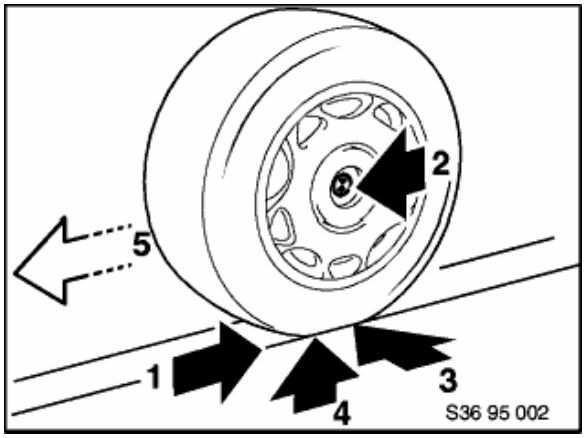

Figure 2: Forces acting on the wheel

1. Braking force
2. Tractive force
3. Lateral force
4. Normal force
5. Direction of travel

Suspension characteristics

The tyre is the first suspension element between the roadway and the vehicle. By means of elastic deformation, it evens out bumps in the road. The wheel and axle no longer have to track all the bumps and the task of the vehicle suspension system is simplified.

The tyre reacts with a different form of elastic deformation depending on the type and size of the bump and on the speed at which the bump is impacted.

The tyre as a whole can oscillate about the axle or take on forms of deformation of a higher order (deviation from

the circular shape) right up to localized deformation.

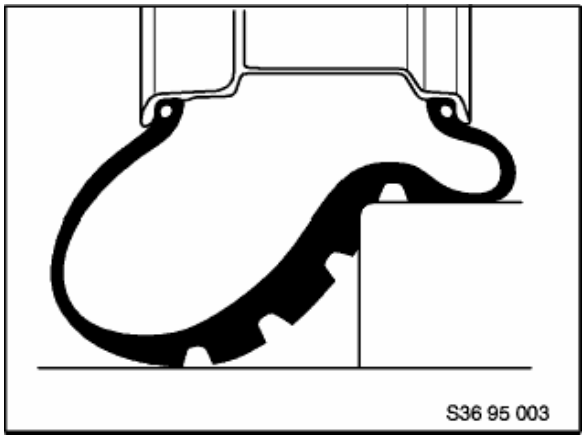

Figure 3: Deformation of the tyre tread at an obstacle

Tread

One of the most important features of a tyre is its tread pattern. This should offer the greatest possible degree of driving safety under all road conditions and good contact.

Tyres without a tread pattern have the maximum footprint possible for the size of tyre in question. Such tyres are, however, only used in exceptional situations such as in car races.

In practice, the tread has a pattern which is divided into lugs and grooves. A good tread pattern is above all important on wet roads. The lugs divide up the film of water, while the grooves have the task, up to certain speed, of expelling the water out of the footprint. At higher speeds, aquaplaning occurs.

On a soft surface such as slush or snow, the lugs create tyre/road adhesion which together with the adhesion compound ensures good traction.

The lugs are often subdivided even further by slits in the tread pattern. These reduce tyre noise and also form additional grip edges. These grip edges improve functioning and braking performance. On snow tyres, the slits in the tread provide particularly good adhesion of the lugs on slippery surfaces.

The lugs, grooves and slits also act as cooling ribs. The deformation of the tyre generates heat which can be dissipated by means of these cooling ribs. This lengthens the service life of the tyre.

(For information about tread depth/wear indicators: see section entitled "Tyre Wear", Annex 4).

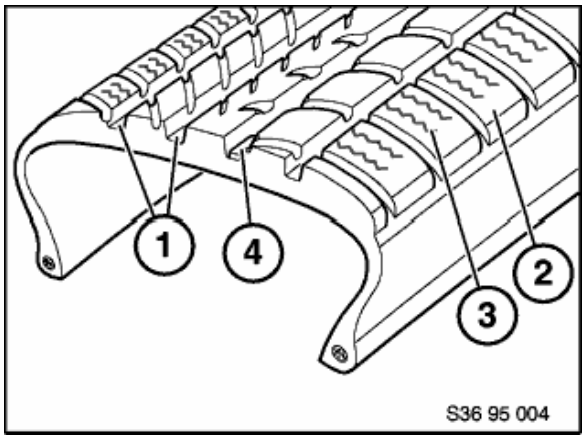

Figure 4: Illustration of tyre tread with lugs, grooves and slits

1. Main circumferential tread grooves
2. Tread lugs
3. Slits
4. Wear indicators

Significance of the tyre inflation pressure

The weight of the vehicle is for the most part borne by the pressure of the air volume and only to a small part by the elasticity of the sidewalls of the tyres. The main role of the air pressure is to give the tyre the necessary shape, so that it is able to fulfil its tasks.

Not only the service life of the tyre, its load carrying capacity and the level of comfort obtainable, but to a great extent also road holding and therefore driving safety depend upon observance of the specified tyre inflation pressure and the condition of the tyres.

If the inflation pressure is too low, the sidewalls of the tyre are deformed by a greater extent. The pressure on the footprint is no longer evenly distributed and it is displaced to the outside edge of the tyre (tread shoulder) which is subject to greater wear. Cornering forces and stability at high speeds are greatly reduced and the vehicle displays changed braking behaviour.

In the course of rotation of the wheel, the sidewall of the tyre is heavily flexed, which leads to increased rolling resistance and consequently to increasing fuel consumption.

Due to the flexing energy, the tyre is heated up considerably. This can lead to permanent damage, right up to symptoms of disintegration and sudden loss of air.

If the tyre inflation pressure is too high, the shape of the tyre likewise deviates from the specification. The diameter of the tyre is enlarged and tread wear is increased particularly in the middle area. Since the footprint is made smaller due to the middle of the tyre not sinking in so much, the level of road grip (tyre adhesion) is reduced. Furthermore, the suspension characteristics become poorer and tyre noise can become louder.

The inflation pressures specified by the vehicle manufacturers must be adhered to. Incorrect tyre inflation pressure is the most frequent cause of complaints. For this reason, the pressure should be checked every 2 weeks and before starting any longer journey. The spare wheel must also be checked.

The loading condition of the vehicle must also be taken into account. When a heavy load is being transported, the inflation pressure must be increased in accordance with the inflation pressure table, in order to compensate for the greater weight.

The tyre inflation pressure must never by measured when the tyres are "warm". While the vehicle is being driven, the tyre inflation pressure rises due to this heating up; this is taken into account by the manufacturer. It would be totally wrong to let air escape from a warm tyre, in order to set the specified value, because the pressure would drop below the specified value once the tyre has cooled down.

If a larger loss of pressure occurs, the cause must be searched for and eliminated immediately, because a damaged tyre can fail unexpectedly even under only a slight load.

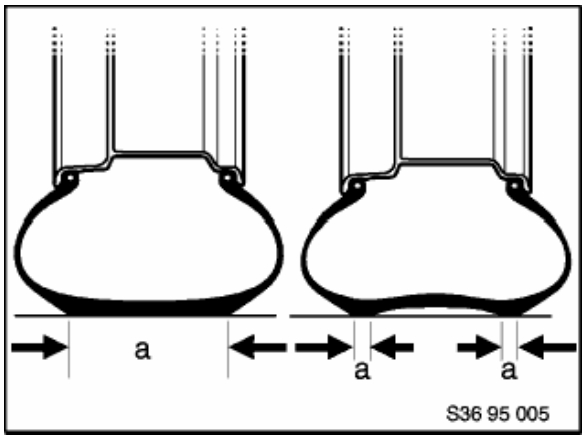

Figure 5: Cross-section of a tyre with too high and too low an inflation pressure

1. Footprint a at too high an inflation pressure
2. Footprint a at too low an inflation pressure