3.1 Consequences of wheel position deviations

Wheel deviations can have different consequences, which can be divided into three main groups:

- premature tyre wear and the causes;
- poor steering characteristics;
- vibration of the vehicle.

3.2 Premature tyre wear and the causes

Abnormal or too fast tyre wear originates when irregularities or defects occur to the wheel, the tyre or the vehicle. Other causes of too fast tyre wear are incorrect use of the vehicle and poor maintenance (figure. 1).

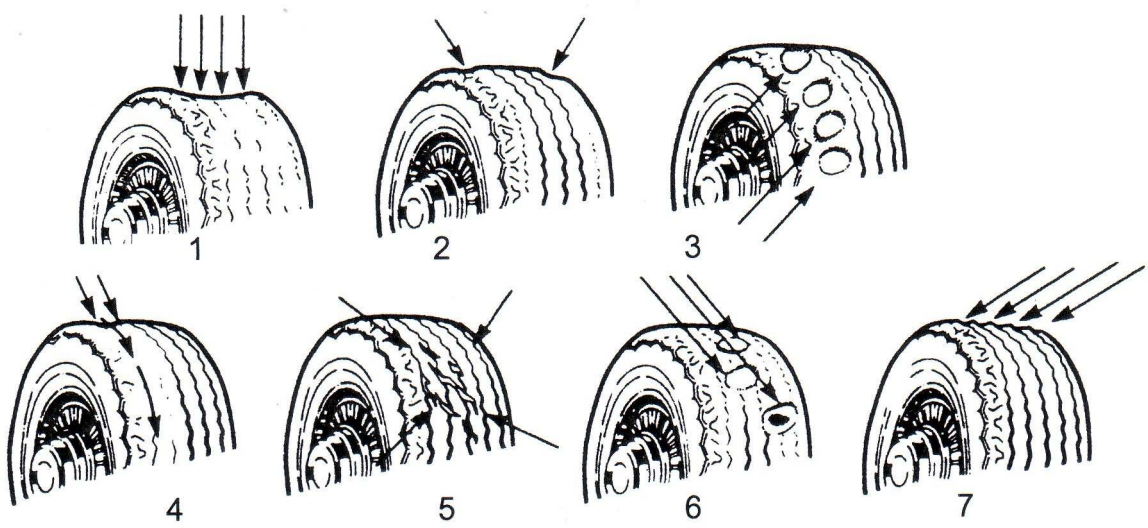


Figure 1: Standard tyre wear drawings, possible causes of uneven or accelerated tyre wear

1. too high tyre pressure
2. too low tyre pressure
3. defective shock absorber
4. wrong wheel distance (camber)
5. damage due to share objects
6. defective braking system or imbalance
7. wrong tracking

If the tread wear is even, but the tyre is wearing quickly, this may be caused by driving at a too high speed or driving in a warm climate with tyres made of unsuitable rubber.

In figure 2 the consequences for the life (efficiency) can be seen for a tyre that is 20% overloaded. The life of the tyre is then decreased by up to 70%. if the tyre has 20% underpressure (e.g. 1.6 bar instead of 2 bar) the life of the tyre decreases by up to 74%.

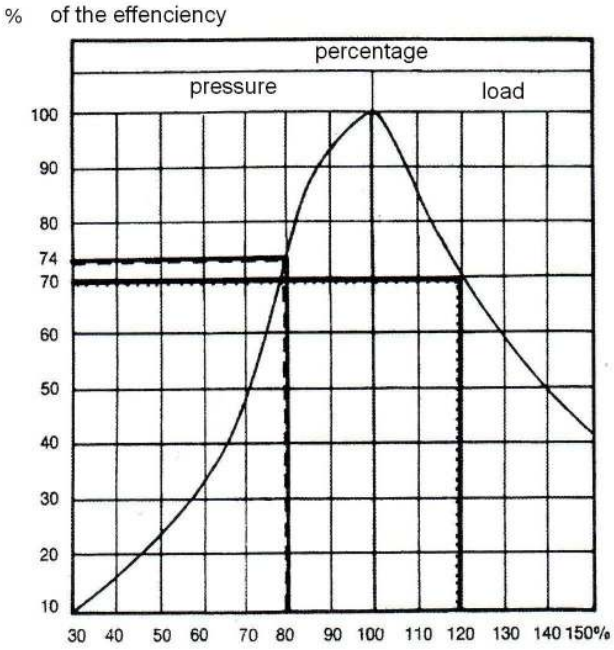


Figure 2: Tyre efficiency as a result of tyre pressure and load

In figure 3 the influence of speed and the ambient temperature is shown. If, for example, efficiency at a speed of 64 kph and a temperature of 19°C is 100%, this efficiency fall to 55% at a speed of 112 kph. The life of the tyre accordingly decreases by 45%.

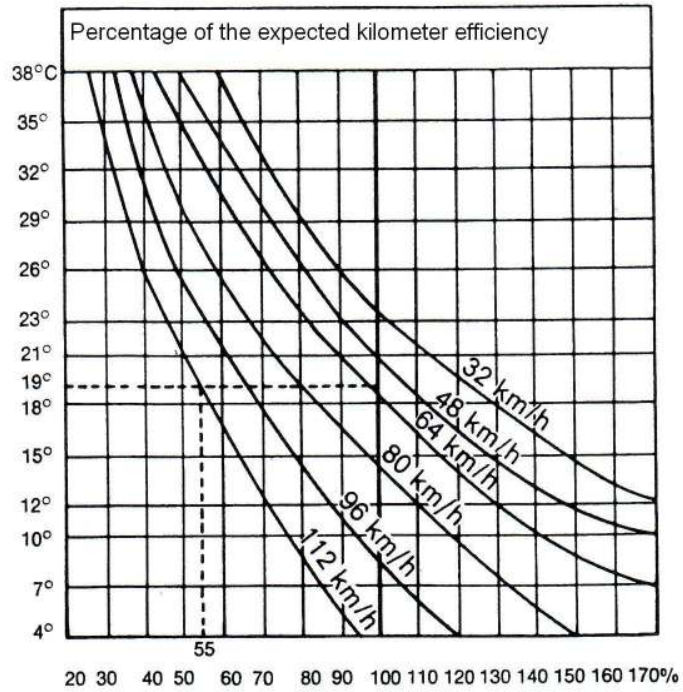


Figure 3: Influence of speed on the life of a tyre

The examples discussed below are shown by number in figure 1.

1. Even wear in the middle of the tyre surface is visible after protracted driving as a result of the tyre construction chosen in combination with many kilometres driven on motorways and/or proportionate to the load or assembly on a too narrow rim. With wide passenger car tyres fitted on cars with high capacities, this wear can be caused by the centrifugal force and the drive power. These both cause greater tractive effort in the rubber, in particular in the middle of the tyre, and greater contact pressure in the middle of the tyre. This can particularly occur as a result of tuning the car.

2. Even wear at both shoulders signifies protracted driving with a too low tyre pressure or too low tyre pressure proportionate to the load and the width of the tyre in combination with much driving around bends (city). The middle of the tyre has too little counterpressure to be sufficiently pressed on the road surface and veears less than the shoulders.

3. Hollowed areas or wavy wear over the whole circumference signify defective shock absorbers, vehicle out of balance, irregular tyre stiffness or play in the suspension. The wheel will start vibrating with the smaltest irregularity. These vibrations have a higher frequency than the rotation frequency of the wheel, so at a number of places the pressure between tyre and road surface increases significantly. In these places the tyre wilt wear, and in between not. The shock absorbers do not suppress this, and the wheel suspension rubbers also allow these extra movements. Imbalance and irregular tyre stiffness are the causes.

4. Single-sided tread wear is usually caused by an incorrect camber. The wheel is then out of square on the road surface. With the deformation of the tyre the wheel turns on different circumferences (figure. 4).
One side wilt slip and result in shoulder wear without ridge formation. This can remedied by aligning the vehicle. Single-sided wear over a small part of the circumference signifies run-out (eccentricity) of the tyre or the wheel.

Single-sided tread wear can also be caused by excessive use of power steering or an error in the toe-out in a bend. Only a close study of the tyre can decide definitely.

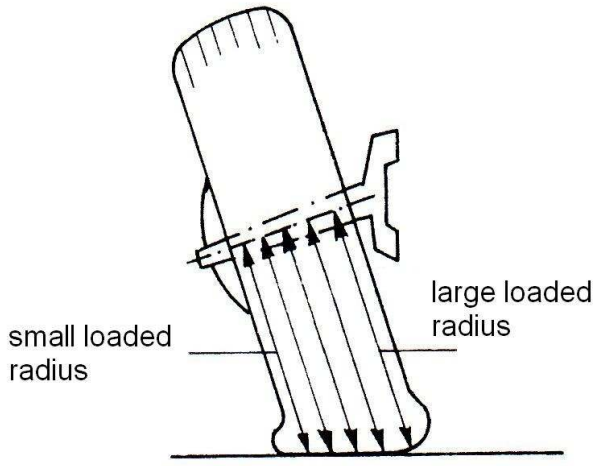


Figure 4: one-sided tyre ward

5. A small area of wear can penetrate to the tyre belt and signifies defects in the brake system (running out of true, twisting in the brake disc, oval brake drums) or protracted braking with blocked wheels.

6 Hollowed areas in random places over the tyre surface can signify defects in the brake system, radial run-out in the tyre/wheel combination or carcass breakage.

7. Serrated or flaky tread wear in the transverse direction is usually found on the outside or inside and can be felt easily by hand when the hand is moved over the tyre (figure 5). In one direction the tyre resistance wilt be greater because of protruding ridges. This form of excessive tread wear is usually caused by deviations in the tracking. Ridge-forming facing inwards signifies too much toe-in. Ridge-forming facing outwards signifies too much toe-out. Defects in the suspension, the control and load differences also cause serrated tread wear. This form of wear can also be caused by "rally driving" (four-wheel drive). There may also be damage to the wheel guide or collision damage.

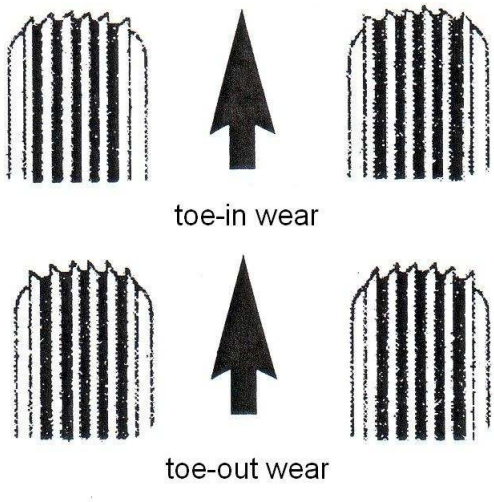


Figure 5: serrated wear

8. Another tyre condition is the cone effect or 'conicity' (figure 6). This conicity influences the straight run-out characteristics of the tyre. The cause of conicity is the inaccurate or tilted application of the belt, so the distante between belt and tyre surface differs to the left and right, and so also the tyre diameter (D1 and D2). The consequence of conicity is excessive tread wear and poor driving stability. To eliminate the cone effect, tyre fitters always put the DOT code on the outside of the wheel, but naturally not on direction-related tyres! (an out of square steering wheel can be a consequente of conicity).

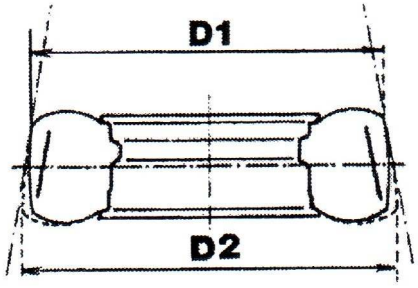
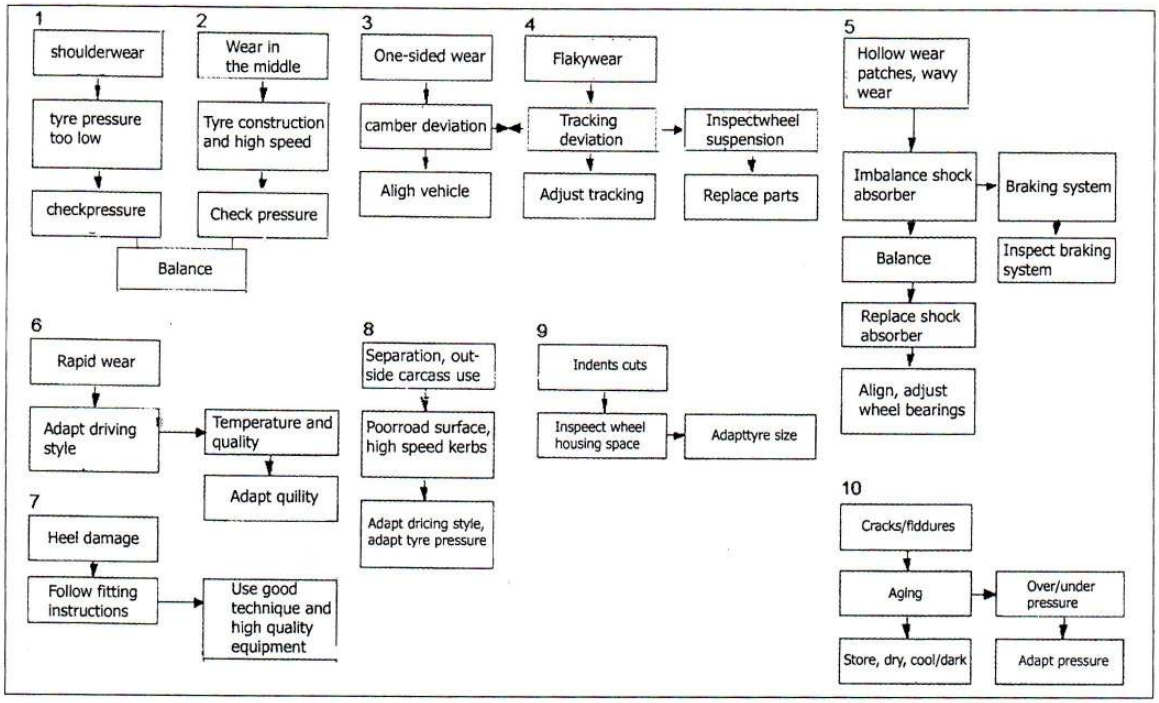


Figure 6: cone effect

The diagram below gives another summary of the most common forms of tyre wear and damage with their causes and possible solutions.



9. Serrated wear in the longitudinal direction of the tyre is common on non-driven axles. Because the separate features of the tyre tread forming tread design are not driven but do deform, they wear more quickly on the one side than the other.

The wear as discussed above results in the following:

- a shorter life;
- poor driving comfort;
- poor stability;
- poor handling in bends due to reduced grip;
- excessive carcass damage;
- overheating.

3.3 Imbalance in tyre combinations

As a result of small disparities during manufacture, small irregularities can occur in tyres. This means that the mass of the tyre is not evenly spread.
Small irregularities and out-of-roundness can also be found in the wheel disc as a result of manufacturing tolerances. The consequence is that the wheel as a whole displays imbalance. White the wheel is turning, radial forces originate (from the middle point outwards) that are not evenly spread over the circumference. All these forces should eliminatie each other, but this is not the case because of the mass imbalance (figure. 7).

This imbalance of mass rotates with the wheel and causes the wheel to move vertically and laterally around a vertical axis due to flexibility in the rubbers of the suspension. As the rpm increases, the forces of imbalance become greater and the effect becomes more noticeable. This can be eliminated by statically balancing the wheel as a whole. Static imbalance (figure 7) means a wheel slowly running out to zero rpm clearly has one position in which it will remain.

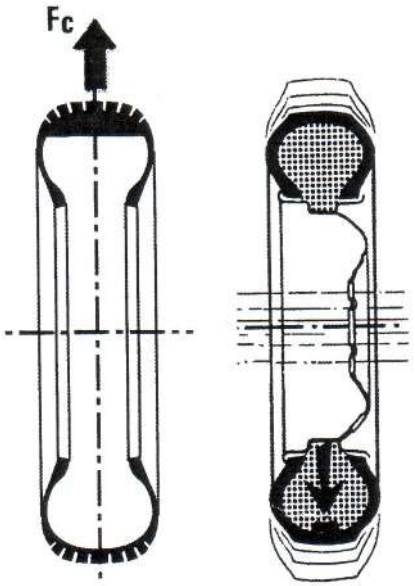


Figure 7 : static imbalance

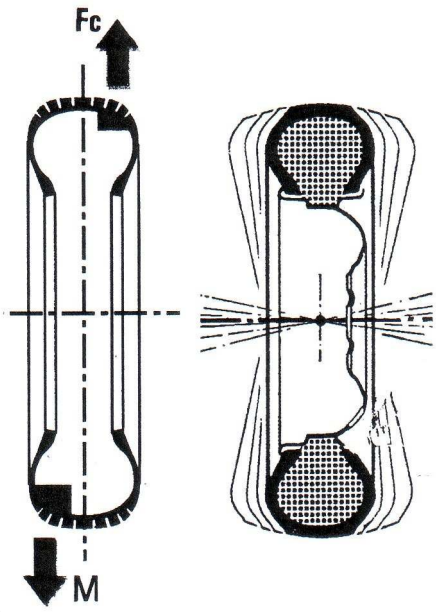


Figure 8: dynamic imbalance

If the wheel displays such a position, by using smal) weights on the edge of the rim the imbalance can be eliminated. Then, however, dynamic imbalance remains because the imbalance of mass and the balance weights, viewed from the direction of the axle, are not in line so they cause a rotating moment (figure 8). This makes the wheel shimmy (figure 9).

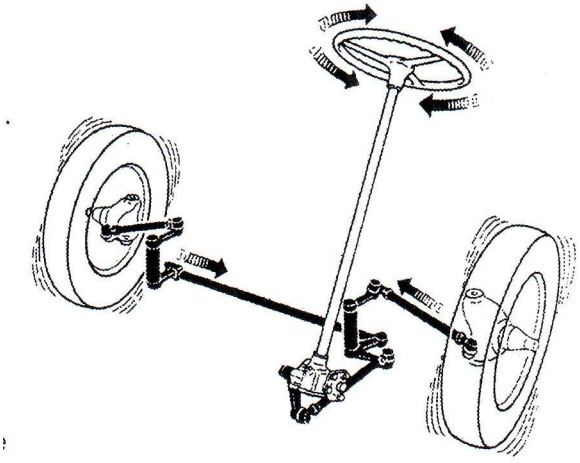


Figure 9: shimmy

3.3.1 Vertical and lateral run-out in tyre combinations

It is possible for the wheel to still vibrate after balancing. The cause can be vertical run-out (figure 10) or lateral run-out. Vertical run-out is the up and down movement of the axle of the turning wheel due to out-of-roundness (eccentricity, figure 10). Lateral run-out (figure 11) is a consequence of the askew position of the tyre on the rim due to dirt between heel and rim edge or the poor fitting the heel. Lateral run-out can also occur after a wheel is fitted on a car. The cause is then askew assembly on the axle due to damage or dirt.

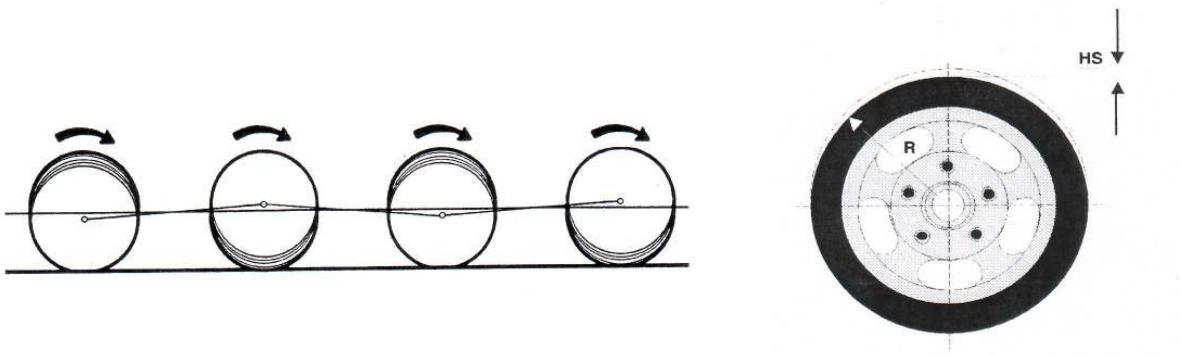


Figure 10: vertical run-out

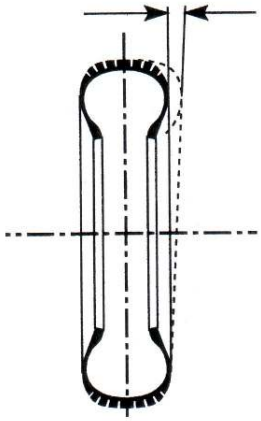


Figure 11: lateral run-out

3.4 Tasks and questions

1. *Define the ward wheel deviation.*
2. *State any two (2) consequences of wheel deviation.*
3. *What are the possible causes of the tyre wear shown in figure 1:, 2:, 3:, and 4.*
4. *State one factor that contributes to a serrated flaky tread-wear.*
5. *In relation to tyre wear, state one cause of conicity.*
6. *Explain what is meant by static balance?*
7. *State one method by which imbalance can be eliminated.*
8. In tyre balancing, explain the following terms:
   (a) Vertical-run-out (b) Lateral run- out
9. *Give three effects on a worn out tyre.*
10. *On which type of axle is serrated wear in longitudinal direction common to?*
11. *Define the following*
    (a) premature tyre wear
    (b) poor steering characteristics.
12. *State any negative impact of over loading vehicle tyre.*
13. *What signifies even wear at both shoulders of a tyre?*

