DB Manual: Railway system knowledge

Integrated rail system

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Due to the increasing internationalisation of the railway sector, the DB reference book "Railway system knowledge – How the German rail system works" is an essential piece of work for all railway employees. It is also a practical tool for professionals starting a new career in the railway sector and employees involved in English-language railway projects in Germany and abroad. This reference book describes the German rail system in its entirety and explains the interrelationships between its various subsystems. The following article is an excerpt from the chapter "Integrated rail system".

Subsystems and mutual dependencies

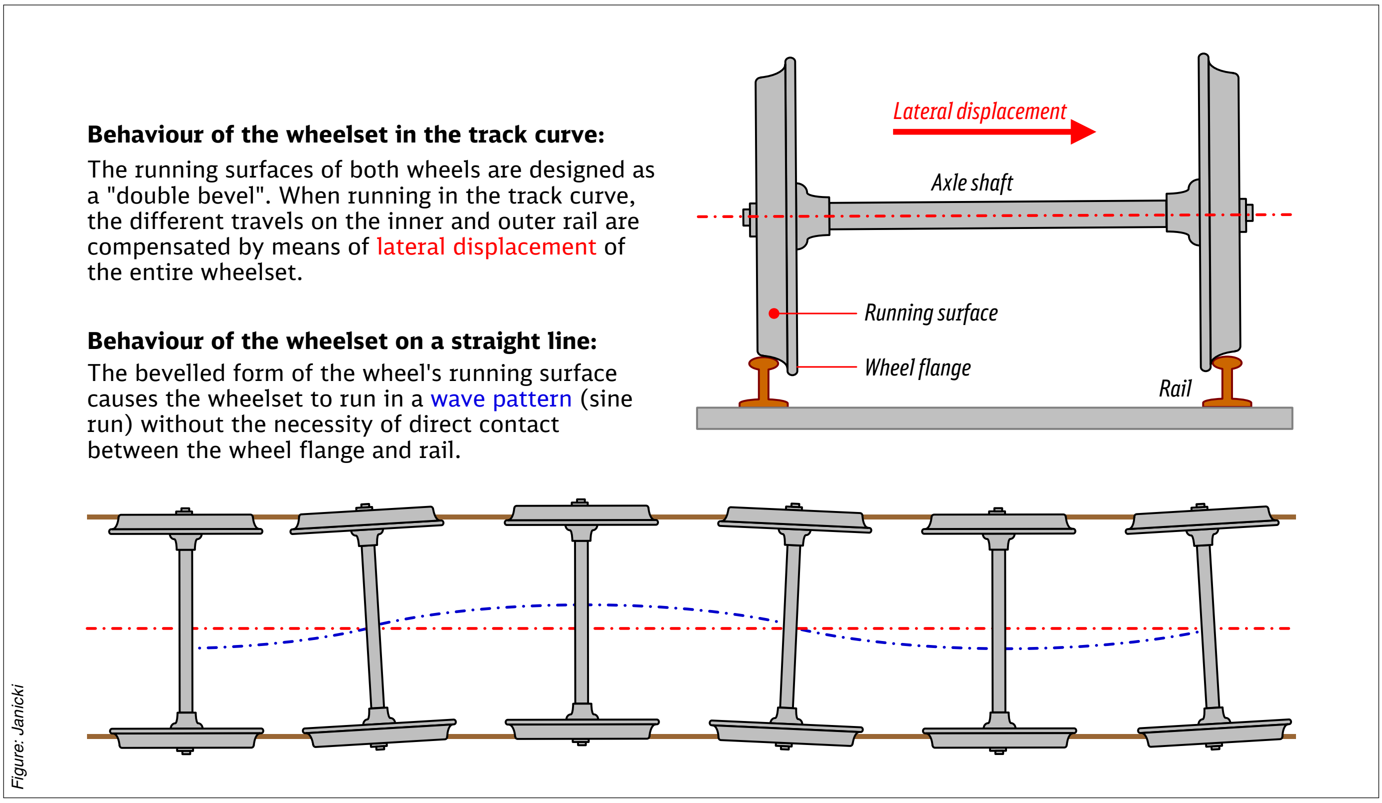
Wheel-rail system

The tractive, braking and guidance forces are transferred via the contact area, which is only approximately 4 cm^2, between the wheel and rail. Due to the high forces, the choice of the materials that are used is very important. To minimise wear, the hardness of the steel used for the rail and the wheelset must be coordinated. The geometrical dimensions and tolerances of both components must also be coordinated so that reliable track guidance and high running smoothness can be guaranteed.

The wheel profile consists of an inner wheel flange and a bevelled running surface. In combination with the inclination of the rail, this guarantees reliable track guidance on straights and in curves. The wheel flange is necessary to guarantee reliable track guidance and to enable forced guidance in very tight curves (e.g. private sidings). Gauge clearance is required for unconstrained wheelset running.

Track guidance (sine run)

To enable track guidance on the track, the wheels are equipped with wheel flanges. On straight lines, the bevelled form of the wheel's running surface causes the wheelset to run in a wave pattern (sine run) without the necessity of direct contact between the wheel flange



Wheelset on a track curve

and rail. The wheelset centres itself, and the wheelset axis describes a sine curve depending on the route. As soon as the wheelset no longer runs completely centrally on the rails, the wheels rotate around different rim diameters. The wheel offset outwards from the centre of the track runs over a larger circumference than the opposite wheel, and pulls ahead in the direction of travel. This centres the wheelset again towards the centre of the track and beyond. The other wheel now runs over the larger circumference, pulls ahead, and the wheelset slews back again. This wave-like movement of the wheelset continues until a new, external influence such as contact between the wheel flange and the running edge stimulates another wave movement.

Running in curves

To compensate the different travels of the wheels fastened to the axle shaft in track curves, the wheelsets should be set as radially as possible. The wheels' running surfaces taper out-wards. As a result, the outer wheel in the track curve runs over a greater circumference than the opposite wheel. Due to this lateral displacement and the resulting, different radii at the two points of contact, the different distances covered by the two wheels of a wheelset are virtually compensated in the track curve.

Track gauge

The minimum distance of the two rails between the inner surfaces of the rail heads on the so-called “running edge” is called the track gauge. Due to historical reasons, there are a variety of different track gauges around the world. Generally, the narrower its gauge, the less expensive it is to build a railway. Narrower track gauges are also easier to implement on accordingly difficult train paths. This is why many “mountain lines” were built as narrow gauge railways.

The track gauge most frequently found in Europe is 1,435 millimeter (mm), and is referred to as standard gauge. In deviation from this, larger track gauges are referred to as broad gauge, and small track gauges as narrow or metre gauge. Broad gauge, which can be found in Spain, Portugal, Finland, the Baltic states and the Commonwealth of Independent States, is also very important for European rail freight traffic in addition to standard gauge. Larger narrow gauge networks exist in Switzerland, Greece, France and on some Mediterranean islands. In Germany, narrow gauge networks can be found in various island, museum and factory railways as well as at numerous tramway companies. The Harz narrow gauge railway, which has an interconnected railway network measuring around 140 kilometre (km), enjoys a special status in Germany.

On installation of a track, the track gauge tolerance on standard gauge tracks is ± 2 mm. During operation, it may be 1,430 mm in the case of gauge narrowing and a maximum of 1,470 mm in the case of gauge widening. In track curves, the track gauge is widened slightly to prevent the wheels from “jamming”. Adherence to the operational limit values is checked regularly through

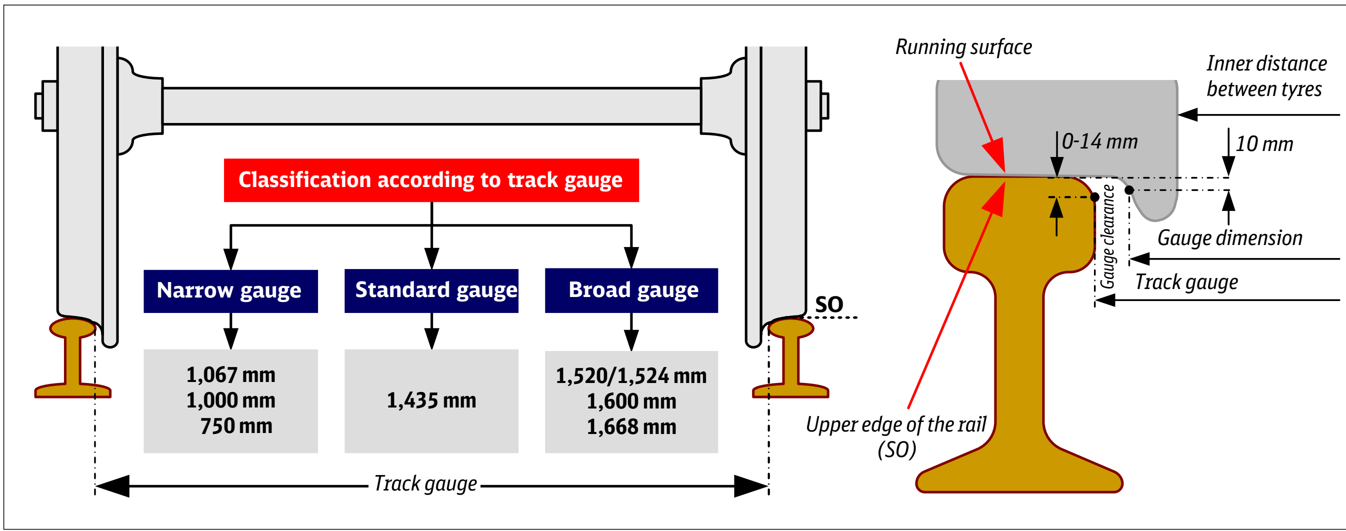


Figure: Janicki

The track gauge is the smallest distance between the inner surfaces of the rail heads. On standard gauge tracks, it is measured in the area of 0 to 14 mm beneath the upper edge of the rail (SO)

measurement runs together with the quality of the track position. Deviations and changes can therefore be immediately ascertained and corrected.

The different track gauges prevent standard gauge wagons from being used in through traffic to railways with a deviating track gauge. However, the availability of special wagons whose gauges or axles can be switched enables continuous rail transport with these countries. Another alternative is laborious transfer-loading onto freight wagons with the corresponding track gauge or transport in containers.

Derailment

If a railway vehicle leaves the track in an uncontrolled manner due to sliding or running off while moving, this is referred to as derailment. A vehicle is regarded as derailed even if it subsequently re-rails itself. Track guidance usually leads to safe railway vehicle running. However, exceeding physical limits, incorrectly coupled vehicles, external influences (for example objects in the track) and unstable locations on the track (e.g. rail breaks) can lead to unstable running in which track guidance is lost, thus posing the risk of derailment.

Tilting technology

The maximum permissible speed of a rail vehicle in a track curve is dependent on the factors of safety and ride comfort. On the one hand, derailment protection and super-structure stability must be guaranteed to be able to increase the speed. On the other hand, the lateral acceleration acting on the passenger must be minimised to such an extent that comfortable travel is possible.

The use of vehicles with tilting technology is an alternative to the construction of high-speed lines. Such vehicles can run through track curves faster than conventional vehicles. On cornering, the technology housed in the bogie inclines the vehicle's body inwards into the track curve, thus compensating the lateral acceleration that increases significantly at higher speeds. The tilting technology is used exclusively to ensure ride comfort. This solution, which is simple in principle but technically complex, enables cornering speeds to be increased by up to 20 per cent. Unfortunately, the tilting technology causes increased stress on the track in curves.

There are two different tilting technology systems: in active tilting technology, the vehicle body is inclined using hydraulic or electromechanical actuators, and is returned to its horizontal position at the end of the track curve. In passive tilting technology, the vehicle body tilts solely due to the centrifugal forces that occur on cornering. ■