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OP Vzdělávání pro konkurenceschopnost
INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

KKS/ZDMT
Rail vehicles

Presentation 10

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Innovations of Study specialisation Transport Vehicles and Handling Machinery with respect to market needs

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CLASSIFICATION BY TRACKS

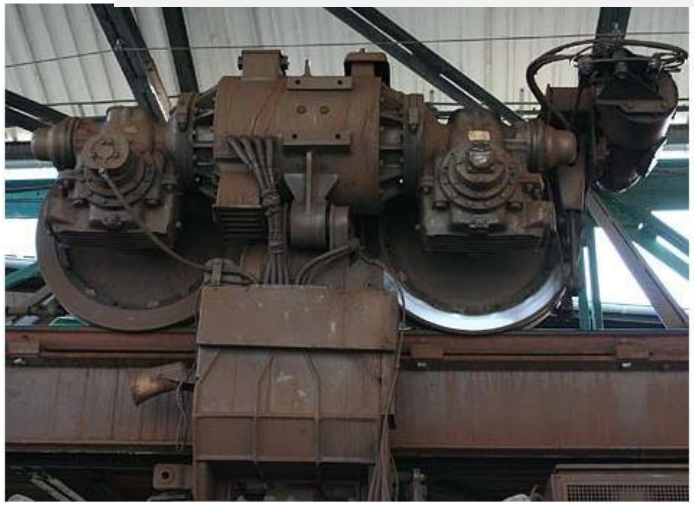
A firm connection with the track is the main and typical sign of a rail vehicle. Unlike road transport, the vehicle is not only carried but guided by the track. In strict terms, rail vehicles are those which operate on routes formed by rails.

- Direct contact with track
  - Wheel-rail
    - Railway track
    - Single rail track/monorail (suspended or straddle-beam)
  - Wheels with tyres
    - Single rail track/monorail (suspended or straddle-beam)
    - Two-foot track
- No direct contact with track
  - Floating
    - On air cushion
    - Magnetic field

CLASSIFICATION BY TRACKS

Suspended monorail in Wuppertal, Germany

TRANSRAPID research vehicle with linear el.motor

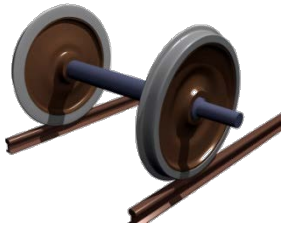


Drive bogie of suspended monorail in Wuppertal

Paris Metro train using rail-tyre contact

CLASSIFICATION BY DRIVE PRINCIPLE

- Drive
  - adhesion



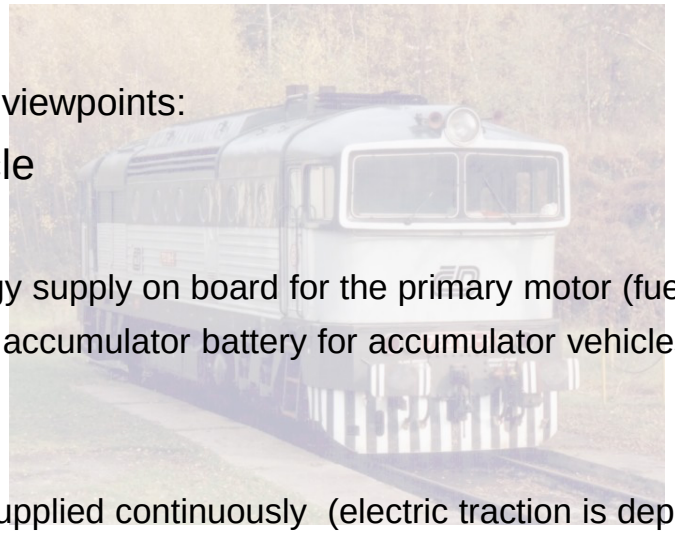
  - Non-adhesion
    - Rack and pinion railway
    - Linear electric motor

Rack and pinion railway in Štrbské Pleso (SVK)

- Rail vehicles
  - Railway
  - For urban public transport

TRANSRAPID test train with linear electric motor

RAILWAY VEHICLES

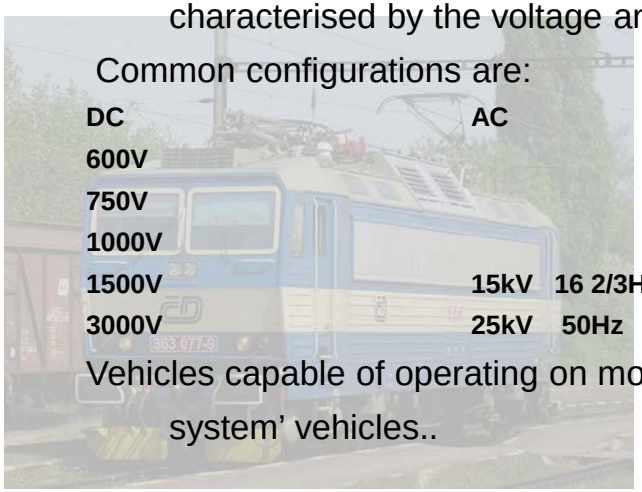


The drive vehicle can be classified from various viewpoints:

- Transmission of energy to vehicle
  - Independent traction

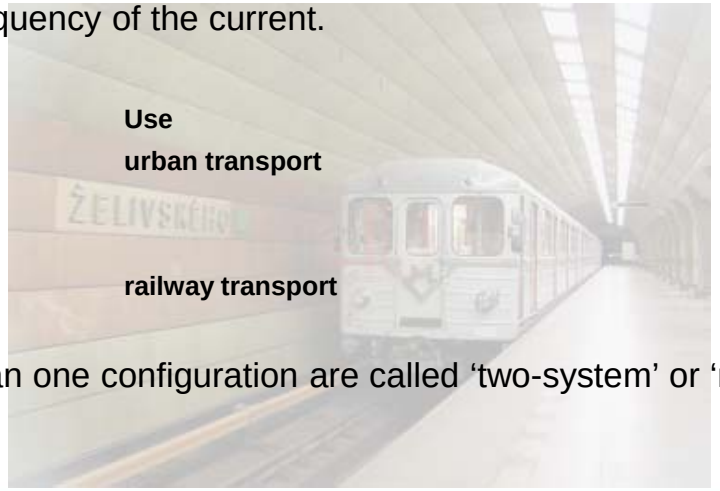
    There is a container for the energy supply on board for the primary motor (fuel container for steam and traction motors, or accumulator battery for accumulator vehicles with independent traction)
  - Dependent traction

    Energy for the traction motor is supplied continuously (electric traction is dependent on electric connection via trolley or rail). An important difference is the current set up, characterised by the voltage and frequency of the current.



Common configurations are:

DC	AC	Use
600V		urban transport
750V		
1000V		
1500V	15kV 16 2/3Hz	railway transport
3000V	25kV 50Hz	



Vehicles capable of operating on more than one configuration are called ‘two-system’ or ‘multi-system’ vehicles..

RAILWAY VEHICLES

Drive vehicle

A drive vehicle or traction vehicle is one where energy is supplied from the external environment by fuel or electrical energy converted into mechanical energy, transmitted to a traction mechanism on the axle, i.e. locomotive wheel (wheel set). A locomotive is a mechanism for moving a dependent railway vehicle along rails. The main task of a railway drive vehicle is to transport a train or a connected series of wagons or other railway vehicles. Drive vehicles are equipped with a power plant, cooling equipment, and other equipment for the functioning of the vehicle and train (electric power supply, compressed air supply, etc.)

- Traction unit– primary source on vehicle
  - Steam– steam driven wheel sets
  - Motorized – piston combustion engine,
    – wheel sets driven by transmission of different power sources
    - Mechanical
    - Hydraulic - hydrodynamic
      - hydrostatic
    - Electrical
    - Combined (e.g. hydromechanical)
  - Electrical

Series 751 motor locomotive

- Motorized locomotive- power transmission

Power transmission is spoken of mainly in motor traction. Transmission of power, more accurately, transmission of power from the combustion engine to the wheel set, is ensured by staying close to the ideal traction characteristics. These have a hyperbolic curve, whereas the torque of a combustion engine is completely different. Thus a wheel set driven directly by a combustion engine would be unsuitable. This is solved by inserting an intermediary element between the output shaft of the engine and the transmission on the wheel set. This element is the transmitter of power. There are several types of power transmission:

- Mechanical
- Hydraulic– hydrostatic
- Hydraulic– hydrodynamic
- Electrical

RAILWAY VEHICLES

- Mechanical transmission of power

In locomotives with mechanical transmission of power, power from the combustion engine is transmitted to a manual or automatic gearbox. From the mechanical gearbox, power is transmitted to the wheel set. Mechanical transmission of power is used for low power. It is distinguished by its simplicity, but losses arising through transmission are significant.

Diesel locomotive 700 series

Diesel car 801 series

- Hydraulic transmission of power – hydrostatic and hydrodynamic

Hydraulic transmission of power is based on pressure, or rather the kinetic energy of a liquid, which transmits power. Hydraulic transmission of power is divided into hydrostatic and hydrodynamic.

Hydrostatic transmission of power works on the principle of static pressure in the hydraulic pump - hydraulic motor unit. The hydraulic pump compresses the liquid which then turns the hydraulic motor which provides the drive.

Hydrodynamic transmission of power is formed by a hydrodynamic transmission which is composed of several converters. A converter is formed of a hydraulic pump, a free-running reactor and turbine blades. The blade wheel of the hydraulic pump throws liquid at the turbine which then utilizes the kinetic energy of the fluid. The free-running reactor is positioned between the pump and the turbine and provides increased efficiency of the equipment because of the fluid directed at the turbine. Switching the convertor is usually performed by an oil slide valve.

RAILWAY VEHICLES

Diesel locomotive series 726 with hydrodynamic power transmission

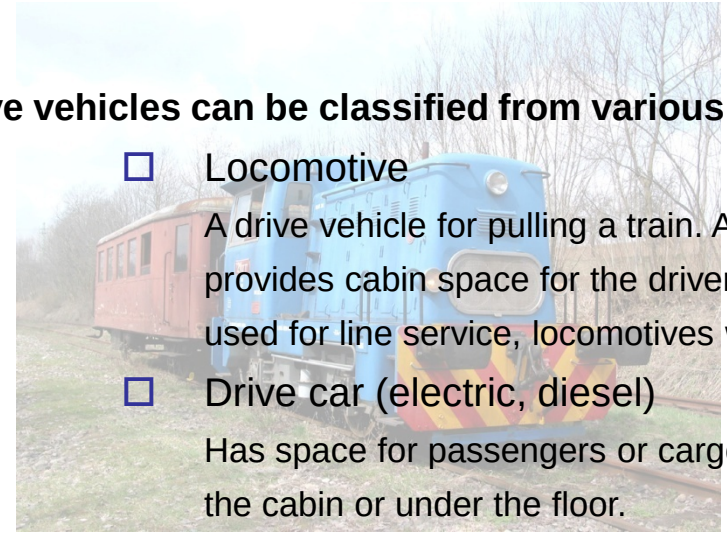
Diesel car series 854 with hydrodynamic power transmission

- Electric transmission of power

Electric transmission of power is one of the most widespread modes of transmission and has many advantages. It is based on a drive from an electricity generator powered by a combustion engine. The current is used to supply the electric motor driving the wheel sets. Electric transmission is suitable for the highest power. It is very efficient. A disadvantage is the relative complexity of regulating the transmission.

Modern diesel electric locomotive series 2016 made by Siemens

RAILWAY VEHICLES



Drive vehicles can be classified from various viewpoints:

- Locomotive

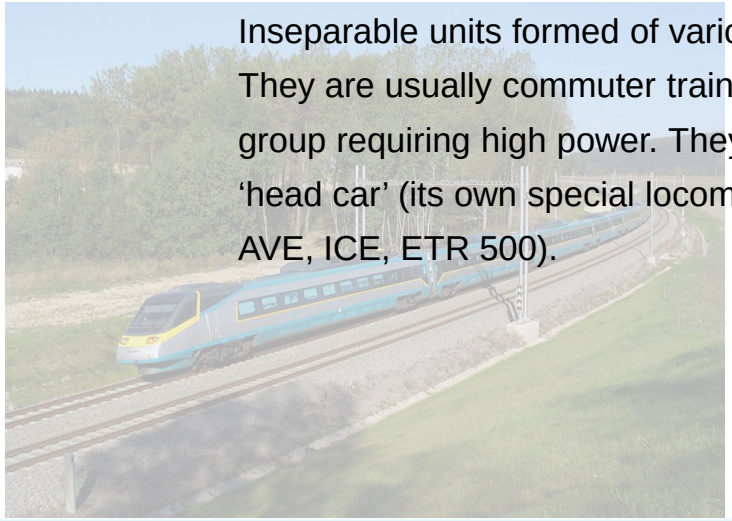
  A drive vehicle for pulling a train. Apart from the drive unit and auxiliary drive, it is also provides cabin space for the driver. Locomotives with cabins at both ends are used mostly used for line service, locomotives with one cabin are used for shunting.

- Drive car (electric, diesel)

  Has space for passengers or cargo. The drive unit must be located either in the engine room, the cabin or under the floor.

- Electric and diesel units

  Inseparable units formed of various combinations of drive cars, carriage , and control cars. They are usually commuter trains and regional transport. High speed units form a special group requiring high power. They comprise either a drive car and if necessary a carriage or a ‘head car’ (its own special locomotive) at the front of the train and a carriage between it (TGV, AVE, ICE, ETR 500).

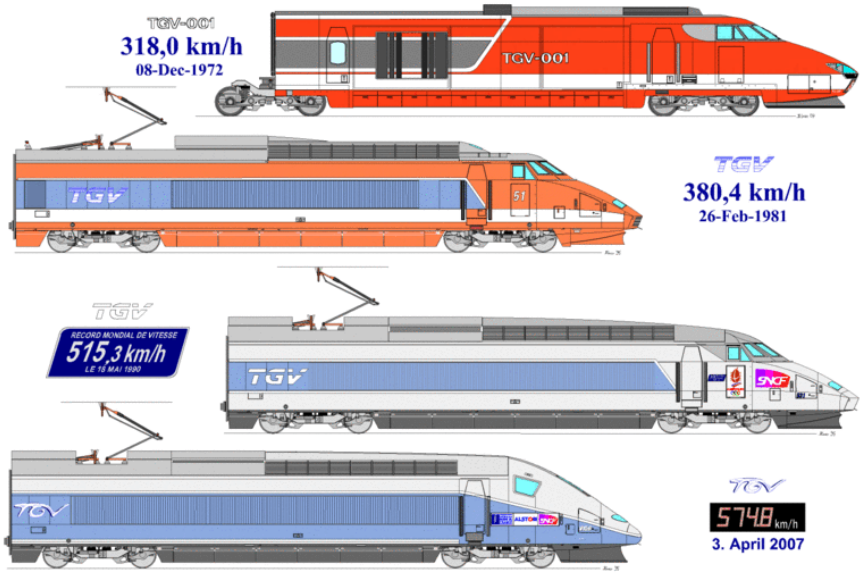


ELECTRIC TRAINS

A special group of electric units are those for operating on high speed tracks. A high speed train electric unit is a train whose design enables it to reach speeds of at least 250km/h.

Europe

France – The prototype TGV 001, driven by a gas turbine, was tested in the 1970s. The electric train is attached directly to the TGV (Train à Grande Vitesse). Today it is a crucial part of SNCF's workforce. It holds the world speed record for an adhesion railway vehicle (574.8 km/h).



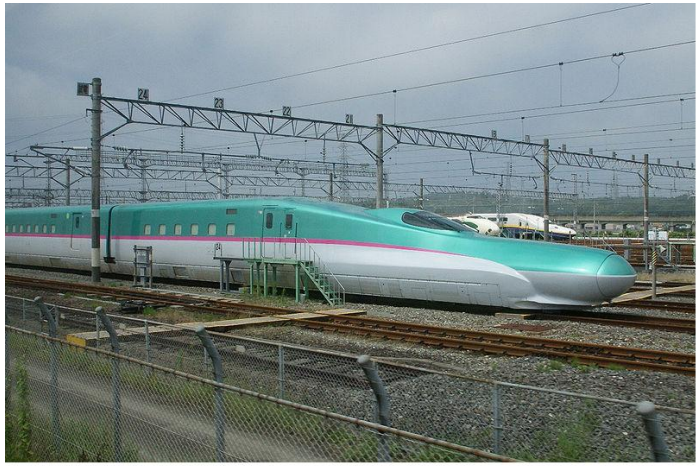
ELECTRIC TRAINS

Germany – High speed transport by ICE (Inter City Express).

ELECTRIC TRAINS

Asia

Japan- Shinkansen started writing the history of high speed transport in the 1960s. The Japanese rail system still has a very high reputation today.



Japan – Shinkansen series E5

RAILWAY VEHICLES

- Pulled vehicles – carriages
  - Passenger
    - For passenger transport (with seats, sleeper car, lounge)
    - For providing a service (buffet, restaurant, observation)

Carriages are designed for operation in a train without limits, or with limits to their use (inserted carriage, connecting car, control car). Double-decker passenger cars have seen increased use in recent years. Max. speed 140 to 200 km/h. A special case are control cars – at one end for the driver.

2nd class Bmz passenger car for Czech Rail

WRRmz dining car for Czech Rail

GOODS WAGONS

- covered
- open
- flat
- intermodal/spine
- refrigerated
- tank
- special

Habbillns series covered wagon

Goods wagons are differentiated according to their construction. They may be specially equipped for handling specific goods, e.g. hopper wagons, container wagons, intermodal wagons for road-rail transport. Max. speed 90 – 140 km/h. Recent years have seen an increase in the use of container wagons.

Container wagon

Es series open wagon

RAIL VEHICLES FOR URBAN PASSENGER TRANSPORT

There are 3 basic groups:

- Trams
- Rapid transit tram – light metro vehicle
- Metro – underground tracks

Trams for urban transport

Vehicles for normal street tracks on double rails at ground level, usually on grooved rails. Voltage is 600V, gauge 750, 1000, 1435 or1524mm.

Independent tram – capable of independent functioning, transporting smaller loads. Usually a 4-axle 2-bogie vehicle with all axles powered.

RAIL VEHICLES FOR URBAN PASSENGER TRANSPORT

Combination of driving and pulled car - allows capacity to be increased as necessary. Use of a pulled car of course lowers the power of the tram.

RAIL VEHICLES FOR URBAN PASSENGER TRANSPORT

Articulated tram – basically a multi-section version of the large cabin tram with its sections mounted on a joint bogie. e.g. the 3-section KT 8D5 with 4 powered bogies.

ForCity Prague Tramcar

RAIL VEHICLES FOR URBAN PASSENGER TRANSPORT

Rapid transit trams, light metro vehicles – a basic characteristic of this transport system is that it operates on a track separated from other traffic. The goal being to increase efficiency, safety and reliability. It has a higher speed than other trams of about 80km/h, power 60-75kW/axle, better travel characteristics, etc. They are built where expensive metro systems are unsuitable.

Rychlodrážní tramvaj v Saint Louis

RAIL VEHICLES FOR URBAN PASSENGER TRANSPORT

Metro vehicles, underground tracks – one of the most efficient urban passenger transport systems. Constructing underground tunnels is very expensive but valid in large cities with a high density of traffic and historical buildings. Electric trains with from 5 to 8 cars are usually used. Current is usually supplied by a third rail on the left side of the direction of travel. Track gauge is usually 1435mm.

MAIN DIMENSIONS OF RAIL VEHICLES

Rail vehicles are described using the following basic dimensions:

A……gauge

B……total length including buffers

C……bogie wheelbase or axle base

D……pivot distance

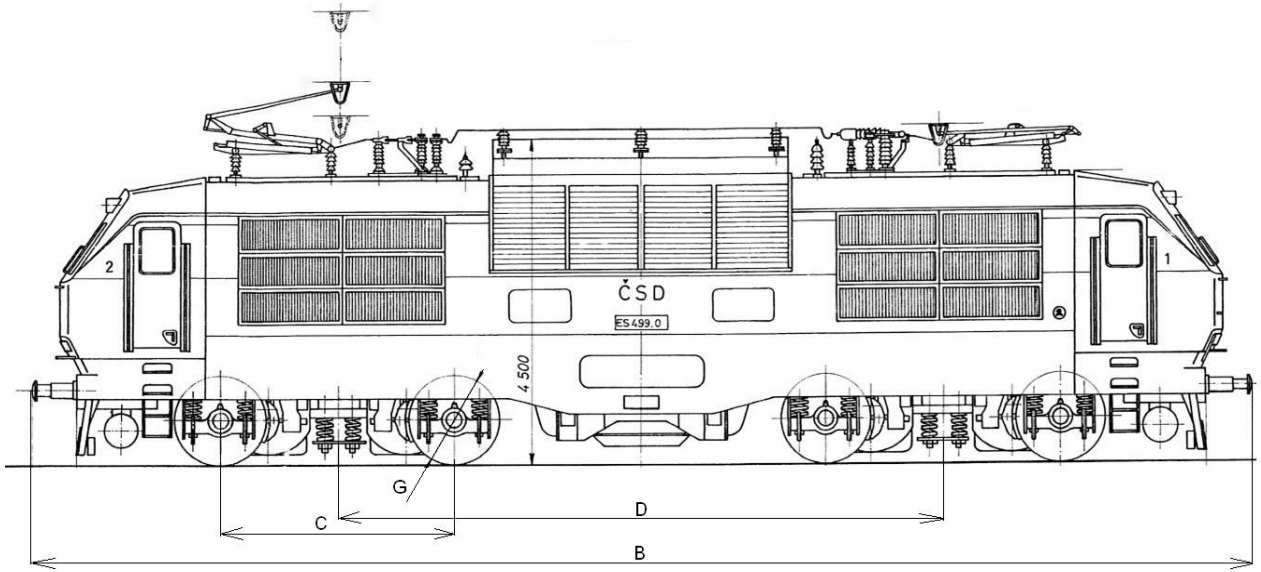
E……max. width

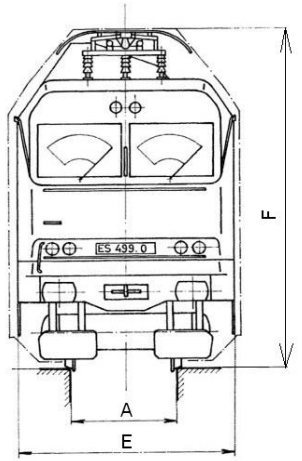
F……vehicle height above rail top

G…...wheel diameter

Other important information:

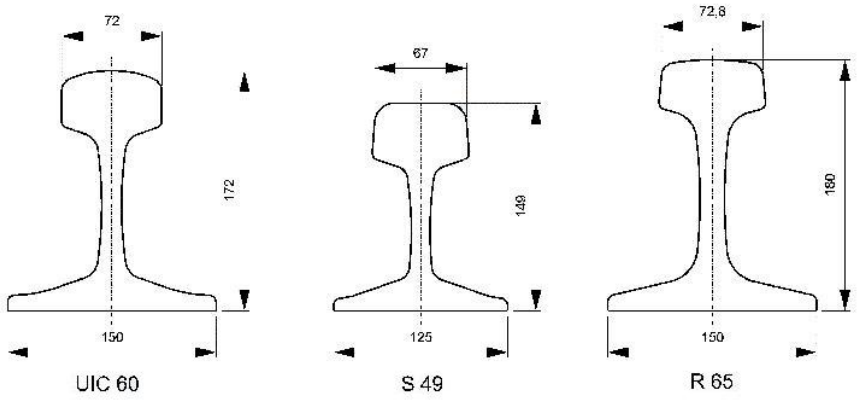
Max. speed
Operating weight
Current system (for dependent traction)





TRACK, GAUGE

A track is formed of a pair of rails which are held at a constant distance by sleepers. A track carries and guides a rail vehicle. It is the basic element of railway infrastructure.



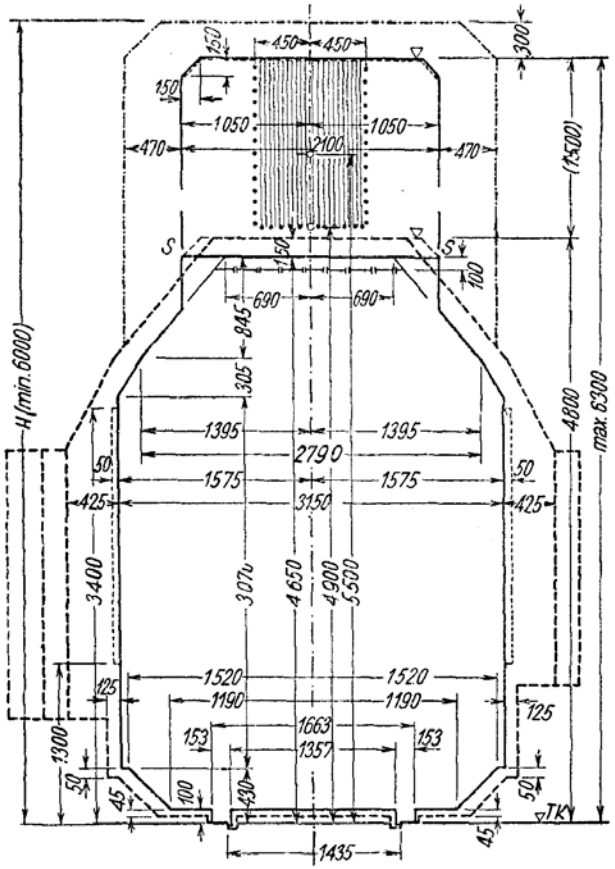
Rail fixed to concrete sleeper with spring clip fastener

Rails are most loaded on their upper part where they come into direct contact with the wheels of the vehicle.

Static/kinetic load gauge and structure gauge

There is a close relation between the static/kinetic load gauge and structure gauge (the minimum clearance outline). Buildings and track equipment must be built outside this structure gauge The load gauge determines how far the vehicle surface can extend.

The relationship between the load gauge and structure gauge is clear from the diagram where both load and structure gauge for the vehicle is shown. The solid line is the static profile for an el. traction drive vehicle. The dashed line indicates the structure gauge.



The load gauge is the most important profile for the designer. It defines the boundaries of the surfaces perpendicular to the track which the vehicle cannot exceed.

TRACK, GAUGE

One of the fundamental parameters of a track is its gauge. It is the distance between the inner surface of the rail head measured 14mm below top of the rail. The most widespread gauge is 1435mm.

Common track gauges used around the world

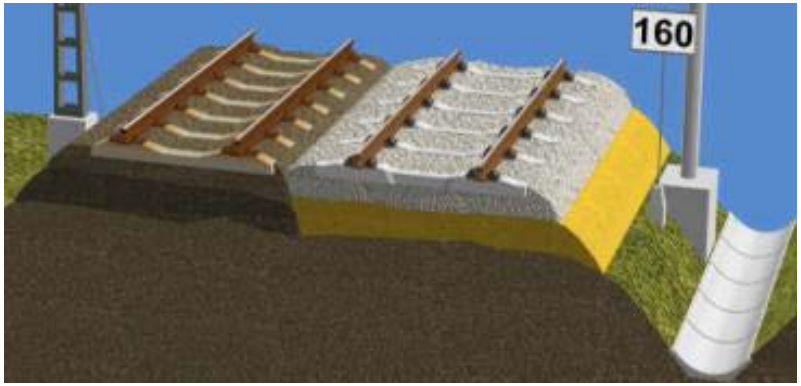
GAUGE	COUNTRIES	% OF WORLD'S TRACKS
1000mm	S. America (Brazil, Argentina)Pakistan, Vietnam, Thailand, Tunisia	7,5
1067mm (Cape gauge)	S. And Equatorial Africa, Indonesia, N. Zealand, Philippines, Taiwan, Venezuela, Ecuador	7,5
1435mm (standard gauge)	Majority of Europe, China, Canada, USA, Japan, Australia, Cuba, Morocco, Algeria	64,1
1520, 1524 (wide)	Former USSR, Finland, Panama, Iran	11,2
1676mm	Argentina, Ceylon, Chile, India, Portugal, Spain	5,5

TRACK, GAUGE

Railway line – the railway bed and the permanent way together

Railway bed – a prepared surface, the upper part of which is railway base

Permanent way – formed of a pair of rails laid on sleepers usually on a gravel bed.



Railways are classified into sections according to the highest allowable loads on the axles and the weight of the vehicle over a standard length.

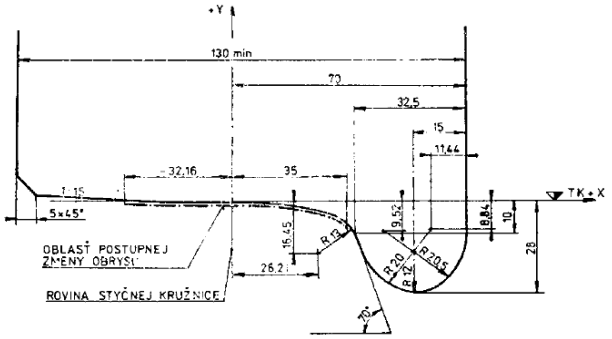
WHEEL PROFILE

The basic wheel profile is the UIC-ORE profile. It originated as the ‘wear profile’ which takes into account the causes of wear on the surfaces of a wheel set and attempts to minimize them.

Wheel profile

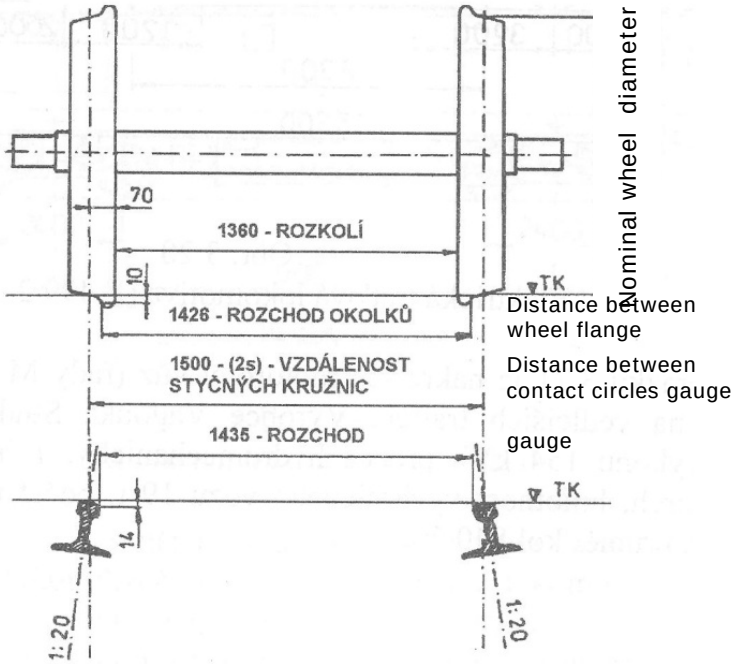
- Conical (formerly)
- UIC-ORE

Profil UIC-ORE



Internal wheel distance
Wheel gauge
Distance between contact circles gauge

Wheel parameters in a wheel set



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