THE LATEST TRENDS IN THE SPHERE OF HIGH SPEED RAILWAY LINES INFRASTRUCTURE

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Abstract:

The contribution focuses on provision of the high speed railway lines (HSRL) in a region, in which the HSRL is being considered. Defined first is the HSRL concept, followed with description of the procedure preceding implementation of such railway line, and basic principles of the HSRL route layout. The idea of the HSRL construction is supported by several successful examples of the HSRL already in service worldwide. Further, the contribution deals with negative influences of the HSRL on environment, and means of their elimination. In closing, the article refers to the modern trends applicable to the HSRL infrastructure and differences between them and the conventional rails.

1. High Speed Railway Line Characteristics

Since this contribution deals with the high speed railway line (HSRL), it will be in place to first describe such definition as accurately as possible, as well as to explain in which aspects the HSRL differs from other railway lines.

Rail systems can be grouped by their different features. In terms of physical features, two differing features can be mentioned that distinguish the two given systems that enable movement of a railway carriage on a long distance railway line – these are the adhesion railway and the railway based on the principle of the magnetic levitation, generally referred to as maglev.

For proper functioning of the adhesion railway, contact between the wheel and the track is necessary; for instance, all public railways in the Czech Republic work on this principle. In the case of the maglev, the carriage moves free of contact above its roadway as the result of the magnetic levitation (based on application of the linear electromotor). In the commercial service, the maglev operates only in the city and suburban transportation, but projects to construct also the long distance rails have been already prepared. The maglev advantages are the high operating speed, fast acceleration and deceleration (which shortens the travelling time), non-existent mechanical wear of the rails during the carriages' movement, and noise only created by the aerodynamics; its disadvantage is the incompatibility with other transportation systems, creating difficulties in building such rails in stages, as well as cooperation with other types of transport means.

In terms of the highest trains' speed facilitated by the railway, it appears that the most suitable grouping is the one in terms of the two European Union Directives on Interoperability of the Transeuropean Railway Systems, which set out differences between the conventional and the high speed railway lines. The high speed railway lines include specially constructed HSRL for speed up to 250 km/h and higher, specially modernised railway lines for speed in the order of 200 km/h, and specially modernised rails of unusual characteristics given by topographic, terrain or urban limitations, to which the speed must be adjusted in each individual case separately.

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Considered as a new, high speed railway track is therefore such adhesion standard-gauge railway (track gauge 1 435 mm is the basic condition of a railway carriage's smooth crossing between various rails) which is chiefly intended for the long distance transport (the railway line length is in the order of hundreds of kilometres), and of which line speed is at least 250 km/h; together with the modernised sections usually rated up to the speed of 200 km/h these rails then create high speed railway network.

2. High Speed Railway Lines Basic Parameters

To determine basic parameters of the HSRL, it is first necessary to establish the reason for the HSRL construction and after that to determine which trains would be using the HSRL. Generally, it is possible to find at least few closely correlating arguments to support construction of the HSRL (that is why several justifications usually come up almost simultaneously), and of which the following could be the ones applicable:

- insufficient capacity of the conventional railway network (especially within large conglomerations with heavy suburban passenger transport)
- slow train speed (long travelling times) by the conventional network (the rail transport is not attractive either to the passenger, or to the transporters, i. e. it is not competitive in comparison with the road and air transport)
- heavy transport streams (having potential of further growth) of some connections, which are presently carried out by different transportation means
- unreliability of the conventional trains (failure to adhere to train schedule due to breakdowns and extraordinary situations), and provision of only low comfort level to passengers (again lack of the rail transport's attractivity and loss of customers)
- independence on non-renewable energy source – crude oil (this reason will become actual in the forthcoming decades; the crude oil crises in the 2nd half of 20th century contributed towards the development of HSRL)

One or more of the following train types fall under consideration to be used as the HSRL service:

- **special high-speed passenger train units** providing long distance transport at design speed of (300 ÷ 350) km/h
- **long distance (alt. regional) passenger trains assembled of a locomotive and passenger carriages** (plus optional controlling carriage), which are capable to reach speed of (160 ÷ 200) km/h
- **transeuropean passenger express trains, transporting at the same time the travellers' passenger cars** (so called trailer-trains) assembled of a locomotive, sleeping and couchette carriages and special freight wagons to transport passenger cars, and which are capable reaching speed of (120 ÷ 160) km/h
- **special freight train units** to transport post (alternatively other similar consignments) of design speed of (300 ÷ 350) km/h
- **freight trains** intended especially for the provision of unaccompanied combined freight transport, which are capable reaching speed of (120 ÷ 160) km/h

Selection of the train types and their parameters play a key role in terms of evaluation of the investment to be expended, including regular operating costs required for the maintenance and operation of the railway line, when usage of HSRL is considered – its attractivity to the transporters.

To be able to determine the basic design parameters of the HSRL, it is necessary to know at least the characteristics of the further mentioned individual train types (and not only of their driving units):

- max. speed, which the train is able to achieve
- max. acceleration to reach the train's max. speed and the braking-down distance from the highest speed
- max. longitudinal gradient of the railway line, on which the train is able to maintain its highest speed, alternatively max. speed, which the given train is able to maintain on such longitudinal gradient, and which is the highest applicable to the highest performance train assumed
- grouping of the train to the loading class (max. mass on the axis and the unit of the carriage length)
- max. length of the train

To determine the design parameters of the railway line it is not crucial as to how the specific category of the train will be marked or what will the exact route of the railway line be, but which characteristics will correspond to the given group of trains. On the basis of the knowledge of the described train types' characteristics and in conformity with the technical norms and legal regulations it is possible to determine the critical parameters of the HSRL layout as follows:

- min. radius of the horizontal curve
- max. longitudinal gradient of the railway line
- min. effective length of the running track in the HSRL operating control points
- min. length of the platform edge of the HSRL stations' platforms

Considered as a necessary condition applicable to carriages of all train types is their assignation to rails with normal gauge, and adherence to the limit dimensions of the carriage's contour in accordance with the international standards. Equipment of the railway line comprising solid parts of the interlocking system and the electric traction can be in principle adapted to any HSRL route. All HSRL parameters must be in conformance with the Technical Specification of Interoperability (TSI) applicable to the transeuropean high speed rail system.

Upon expert selection of the trains and determination of their parameters it is possible to approach the design of the HSRL routes' options. Once their layout is completed, it is necessary to perform the travel simulation of all train types in terms of the dynamics of their travel (affected especially by the longitudinal gradient of the individual track sections), and it is through this that calculation of the travelling time of the train and the traction energy consumption will be carried out, as well as verification that the line speed has been reached.

The bigger the trains' variety and the wider their parameters' range, the stricter the HSRL design criteria become; consequently, search for the optimal route becomes more demanding and its construction more expensive. Big difference between the max. speed of the fastest and the slowest train will manifest itself by the necessity of a large radius of the horizontal curves and increased wear of the railway superstructure. The traction characteristics of the train, considerably influenced by its mass and the power output of the drive-axle assemblies, will manifest itself directly in the max. longitudinal gradient of the railway line.

For the HSRL combined operation (passenger and freight trains) it is possible to determine the radius of the horizontal curves as approximately 7 000 m, and for the HSRL operation of only special high speed units, the radius of the horizontal curve of approx. 4 000 m will suffice. The smallest admissible values of the horizontal curves' radius are further lowered when the solid track-bed is used in the track construction (see chapter 6). The biggest HSRL longitudinal gradient with combined operation can be determined as 18 ‰. Example of the HSRL intended only for the special high speed units are the rails in France, where the TGV units overcome ascend of value of up to 35 ‰, or in Germany between Cologne and Frankfurt, where the ICE 3 units manage the longitudinal gradient of up to 40 ‰.

Especially on the territory of the Czech Republic, characterised by the complex configuration of the terrain, scattered settlements and a unique natural and cultural heritage, even small changes of the limiting values of the HSRL routing parameters play a key role in the capital intensity of its construction.

3. High Speed Railway Lines Routing

In accordance with the reasons that lead to the proposal of the new HSRL and the train types, of which operation is assumed on the HSRL, the HSRL route connects important residential and industrial conglomerations as the sources and target journeys of the travellers (alternatively goods), replaces sections of the low line speed conventional rails, or increases the almost used up capacity of the existing rails. Routing of the new HSRL is constrained by the limiting design parameters and effort to minimise the investment costs of the construction and the future operating costs as well as efforts to make the route as short as possible. At the same time the HSRL routing is limited by the availability of the free space between the residential formations, industrial zones and transport constructions as well as necessity to protect the cultural and especially the natural assets of the territory.

To the limiting conditions indicated in the preceding clause have to be added the problems with location of the passengers' boarding / exit / transfer platforms and crossing of the trains from the high speed rail network to the conventional one and the other way round. One of the biggest advantages of the passenger rail transport in comparison with the air transport is the fact that the train can bring the traveller directly into the city centre, where there is a natural concentration of all services, availability of transfer to interconnecting public transport systems, and about equal accessibility to any place in the city.

One of the options of the HSRL route and a city's connection is therefore termination of the HSRL at the periphery of the residential agglomeration into the conventional network, which will facilitate use of the existing railway to enable trains to consequently travel to the central station. However, this solution has two main snags, which must be examined for each specific case. Firstly it involves extending the trains' travelling time during the travel within the urban area on the existing rails (though reconstructed within the available means), especially for the travellers, who are passing through the given city, and secondly the complications with the saturated capacity of the existing rails, which occurs especially due to concentration of the urban passenger transportation. As advantageous (but at the same time costly) solution appears the construction of a new railway line, segregated from the other transport systems, through the city centre (i.e. at the different height level – above ground, or more often underground), building a station or a stopping place as close as possible to the city centre, or an important changing transport terminal. This option became useful for instance in Antwerp's in Belgium or in Berlin, the capital city of Germany.

Another possibility as to how to provide link between the HSRL and the residential area is to build a HSRL bypass around the agglomeration (plus connecting, as and when possible at suitable places, the HSRL with the conventional rail network), and build on it a completely new railway station, which would be part of the transport terminal, connected to good quality network of other types of the public transport services, and provided with an ample parking space of the P&R type. The advantage of this option, in spite of the longer HSRL route when compared to the preceding option (bypassing the city instead of going through it) is usually shorter travelling time as the result of better design parameters of the railway line (higher line speed), lower investment costs (lesser share of tunnels and bridging structures can be expected on the border of the town residential zone and the rural area, and their lower capital intensity), and the possibility of cooperation with the Individual Automobile Transport. For instance this route was taken by France by implementing the Paris east bypass (LGV-Interconnection), bypassing Lyon with the Lyon-St Exupery (TGV) station, or the new station Avignon TGV.

During the HSRL routing it is necessary to approach its interconnection with other conventional rails with special consideration. These connections, ensuring trains' smooth crossing between both rail networks are on one hand advantageous for both rail networks, but on the other hand can be a source of complications. The contribution brought about by the connection of both rail networks rests in the fact that the travelling speeds of the conventional trains, which use the HSRL for part of their travel, increases, while at the same time the usage of the HSRL capacity increases as well. However, if the rail network interconnections are made in unsuitable places, they can become a potential source of an unreliable operation. Namely, big problems occur in cases when the train, which is supposed to depart to the HSRL at certain exact time, can not do so due to occurrence of delays in the conventional network. Travel of various types of trains onto the HSRL, which in addition are also leaving and coming onto the HSRL at different places, poses high demands on processing of the Train Traffic Timetable (TTT), and that is why there mostly isn't big enough margin to shift the train route during the dispatch control of the operation. The TTT design simplifies when certain types of trains are routed in a certain part of the day only (e.g. the passenger trains mostly during the daytime, the freight trains at night time).

The link between the TTT and the HSRL route (TTT travelling time and track capacity requirements) creates an actual problem in creating efforts for the HSRL parameters to conform rigorously to so-called system travelling times of the Integral Tact Traffic Timetable in the long distance rail transport. This requirement in some connections leads to belief that in these sections it is not the aim to achieve the technically lowest travelling times of the high speed trains, and so it may at first glance appear that all that is required to be connected into the HSRL network is to modernise the existing railway line. However, such doing holds further mentioned pitfalls:

- HSRL are rails primarily intended for the high speed trains, which create own European link system, and therefore it is the changing links between the trains of this type that must be primarily monitored. Creation of the individual high speed lines' tact is naturally desirable, as it leads in terms of the passengers to increasing attractiveness.
- The high speed trains are supposed to compete with the road vehicles travelling on highways, and also with the airplanes – both groups of the transport means are trying to shorten as much as possible their driving and travelling times.
- Construction of any new transport infrastructure is a matter of several years, built at high financial costs, creating a perceivable intervention in the landscape, and its assumed lifespan is at least 100 years. That is why it is necessary to always create certain reserves in the newly built rails' parameters, with a foresight by looking into future, as the carriage stock is developing faster than the construction of the rails and the organisation of the rail transport operation might change even more dynamically.

At the end of this chapter a general procedure of the HSRL design is given: After the technical design of the railway line, determination of the travelling times of all train types and the design of few versions of the TTT is necessary, including the prognosis of the transport streams. Through such prognosis an adequate utilisation of the railway line's capacity can be ascertained, followed by the financial evaluation of the whole construction. The financial evaluation of the construction should include also the all-society benefits and negative aspects, i.e. especially the improvement of the regional transport improvements, increased transport safety, transport increased independence from crude oil, removal of some of the transport streams from other transport systems which create environmental burden; noise and vibration emissions, landscape deterioration (aesthetic, area fragmentation).

4. Successes of High Speed Railway Lines in Passenger Transport

The two tables shown serve as a definite proof of the successes achieved in passenger transport by high speed trains, which operate abroad on already functioning HSR. Table no. 1 as well as table no. 2 [1] show change of ratio between the various types of passenger transport (so called modal-split) always before and after the introduction of the high speed trains connecting Paris – Brussels (trains Thalys) and Paris – Lyon (trains TGV). Growth in the railway transport share indicates substantial potential of the high speed passenger rail transport.

Transport type	Share of transport performance	
	before	after
IAD	63 %	43 %
Bus	8 %	5 %
Airline	5 %	4 %
Rail	24 %	48 %

Table no. 1 – Modal-split, connection Paris – Brussels before and after introduction of Thalys trains

Transport type	Share of transport performance	
	before	after
IAD	61 %	50 %
Airline	17 %	10 %
Rail	22 %	40 %

Table no. 2 – Modal-split, connection Paris – Lyon before and after introduction of TGV trains

In 2001 opened French high speed railway line TGV Méditerranée have taken over gradually in the course of the first two years of its operation 60 % of the airline and the conventional rail transport between Paris and Marseille, which is again the proof of the success of the high speed rail system.

Train connection	With -out	With
Berlin – Munich	12 %	41 %
Madrid – Lisbon	6 %	48 %
Madrid – Barcelona	12 %	49 %
Stockholm – Malmo	25 %	51 %
Paris – Milan	18 %	54 %
London – Brussels	48 %	65 %

Table no. 3 – Share forecast of the passenger train transport of transport volumes on selected connections in 2020 without extension of the HSR network as envisaged by EU

Table no. 3 shows anticipated share of the passenger rail transport of selected European connections in 2020 in the case the HSR network will be / will not be expanded as assumed by the EU. [1]

By the end of 2006 the length of the rails of 250 km/h and higher (HSR) reached in the EU countries length of 4 845 km and by the end of the current year further 800 km of such rails should be added. In 2004 the total transport performance in the high speed passenger rail transport in the EU territory reached 76,300 mio. pkm, which was 21.7 % of the overall passenger rail transport performance. [2]

Two following examples illustrate how successful was the reduction of the train travelling time thank to the HSR: The trains of the supra-national company Thalys, which provide fast rail connection in the western Europe, have managed since the middle of 1996 to cover the route between Paris and Brussels in 2 h 03 min, and after putting into operation further high speed rail sections have shortened the travelling time of this connection from the end of the following year to 1 h 25 min. On 4. 9. 2007 a provisional record short travel time of 2 h 03 min was achieved between the stations Paris Nord and London St. Pancras by the train unit

Eurostar shortly before the commencement of the commercial operation of the new high speed section in the Great Britain [3].

5. High Speed Railway Lines and Environment

The high speed rail transport (similarly as the conventional rail transport and other types of transport) contribute by the virtue of the train operation and the existence alone of the HSR as the continuous line to damages caused to the environment. In the case of the electrical traction of the HSR, the only negative environmental influences of the high speed rail transport are the noise and vibration emissions, and fragmentation of the space by the transport infrastructure. Optimal measures to minimise these undesirable HSR effects have been proposed within the framework of evaluation of construction influences on the environment (process EIA).

Territory fragmentation

Fragmentation of the continuous line construction is understood as division of natural surface areas into smaller areas, which are more or less isolated. As the result of the fragmentation the occurrence of the following unfavourable ecological effects take place and often act simultaneously:

- aesthetic landscape degradation
- barrier effect:
  - limiting free movement of people and interruption of the fauna's migration lines
  - genetic degradation of fauna (separation of fauna population for few generations)
  - loss of so-called internal surfaces (each fauna site has a certain protective zone from its surroundings, which will come into being upon division of the site by the continuous line construction on both of its sides, therefore reducing the fauna's actual life land area)
- appropriation of land (loss of natural localities)
- biotopes degradation (spreading of the invasive types, which easily adapt to the change environment and site, and which consequently drive out the original ones)
- collision of vehicles with fauna – as the result of the HSR fencing it is virtually ruled out
- disturbances and contamination of surroundings of the continuous line construction by operation taking place on it.

The biggest opportunity to eliminate the negative consequences of the territorial fragmentation by the HSR construction is available already during the design of the HSR route, during which it should be avoided going through protected nature localities crossing bio corridors. The height aspect of the design of the HR route has a marked influence on the aesthetic perception of the construction in the landscape and on the design of crossing with possible biocorridors. Influence of the territory fragmentation can also be lowered by provision of artificial banks alongside the HSR, alternatively by routing the railway line in a shallow excavated tunnel instead of the trench or even by complete covering of the rail (by creating a tunnel).

The fragmentation of a region by the transport construction can be minimised by its grouping (parallel routing) into so-called transport corridors. Although the width of the continuous line construction belt then becomes wider, the loss of the so-called live organisms' internal surfaces is smaller and, at the same time, the costs of resolving crossings with the biocorridors become lower. This is done in most cases by routing the HSR right next to the existing highways (e.g. the section Meer – Antwerp in Belgium or Cologne – Frankfurt in –Germany).

So that the presence of HSR does not disrupt the biocorridors serving migration of fauna when the continuous construction line crosses the biocorridor, the design allows for this aspect by providing a specialised construction or by modifying the necessary parts of the construction serving other purposes, so that the preservation of the fauna routes is ensured. The parameters of the migration structure (particularly the shape and the dimensions, separation by flora from the railway line) are determined by the ecologists in terms of the fauna variety which is supposed to make use of such structure. The migration structures are divided in terms of the ecological requirements into different types as shown in the enclosed Table no. 4:

Migration structure to serve fauna	Under-pass	Railway bridge	Special
			Multipurpose
			Large (unmodified)
		Culvert	Special
			Multipurpose
	Over-pass	Bridge	Special (so-called ecoduct)
			Multipurpose
		Railway tunnel	Special (so-called ecoduct)
			Standard (unmodified)

Table no. 4 – The migration structures' division in terms of the ecological needs

Noise and vibrations

Noise and vibrations fall under the most negative aspects of the railway operation. Noise is referred to as any undesirable sound. In terms of the noise emissions, the rail transport is generally considered as less harmful to the adjacent environment than the road transport, but which is less disturbing than the air transport. These conclusions are based on the results observed in the nature, the frequency range and intensity levels of the noise emissions. For example while the level of the acoustic emissions from the motor vehicles on the highway almost does not chance over time, the acoustic pressure's level from the rail transport consists of individual acoustic noises coming from the passing by trains with in-between periods, in which the noise level falls to the background level. Increase of the equivalent noise intensity level from rail transport to the road transport and likewise also the air transport compared to the road transport equals approx. 5 dB(A).

Based on the causes of the generated noises it is possible to separate these to a traction noise, a rolling noise and the aerodynamic noise. Dominant at the speed of up to 60 km/h is the traction motors noise (the electric traction carriages create lower intensity noise than the carriages driven by the diesel engines). Dominant in the train speed range of approx. (60 ÷ 200) km/h is usually the noise coming from the carriages' and wagons' wheels rolling on the rails, and of which intensity is deduced from and affected by the railway and wheel surface roughness and from the method the stretch of rails are joined together (jointed tracks or continuous welded rails). At the speed above 200 km/h the aerodynamic noise begins to prevail, originating from the friction of the individual external parts of the train carriages and wagons against air; the notable source of noise in this case is the current collector, facilitating power supply from the trolley line. The noise intensity level is mainly influenced by the degree of the head of the train's aerodynamic shape, undercarriage's cowling and cowls between the train carriages.

Measures that eliminate the rail transport noise emissions can be divided to active, which prevent noise generation or which at least reduce the noises generated, and to passive, which reduce the influence of the noises already generated on the surrounding environment. The main active means of the noise elimination on the carriages is to maintain smooth surfaces of the wheels, and the correct shape and cowling of the carriages. The main active measure in the high speed railway line infrastructure (apart from, naturally, provision of the continuous welded rails and elastically elastic rail fastening) is the prevention of ripples in the surface of the rails by good quality maintenance of the superstructure, and especially by grinding the rails.

Among the passive measures that can be carried out in the design of the railway track is the laying of the antivibration mats into the earth body of the rail substructure, placing of rubber materials under the loading area of the sleepers, alternatively laying of acoustic panels in the top part of the rail superstructure between the rails. Among the passive measures can also be included suitable routing of the railway line, especially its grade line's design, as by routing of the rail in an earth cut parallel running slopes are created which serve as a natural noise barrier, preventing the noise to spread in the area surrounding the railway. The most expensive noise from the railway lines spreading prevention tool are the anti-noise screens, anti-noise banks or railway line routed intentionally through a tunnel. A secondary positive effect of the anti-noise screens is their function as barriers, which restrict entry of persons and fauna onto the railway line; although in numerous places they spoil the surroundings by their poor visual effect. That is why, especially in the case of a plan to erect a very expensive anti-noise screens along the railway line, it is necessary to substantiate the necessity of having to lower the noise created by the rail transport within the close vicinity of the railway line, by also investigating the possibility of alternative noise liming means, and also making sure that the anticipated noise will be actually truly harmful without such structure

6. Modern Trends in High Speed Railway Line Infrastructure

In comparison with the conventional rails, it is the HSR which take the leading place in terms of the most modern design elements. This is due to the fact that a newly built railway line of a new system, which is expected to be absolutely reliable and safe, including services of the highest possible degree (line speed, traffic carrying capacity) is subjected to very high requirements.

Solid-bed track

Hot news, which appeared in the sphere of the rail infrastructure with the advent of the HSR, is the change from the extensively used rail superstructure design with the gravel bed to the so-called solid-bed track. In the design, the compacted gravel is replaced by the cementconcrete, usually complemented with a cemented base course. There are many different designs and types of the solid-bed tracks in the world, of which some have gone through number of years of routine service, and the others are only going through testing stages. In view of the briefness of this contribution and its focus, only the advantages and disadvantages of the solid-bed track compared with the conventional railway line design (with gravel ballast) will be dealt with in the following summary:

Among the main advantages of the solid-bed track belong:

- far lower maintenance requirements (low maintenance costs, non-disruption of operation by lock-outs), aiming mainly at the correct geometrical position of the track
- long lifespan (decades)
- low structure height (advantage especially in tunnels – lower stope)
- structure's low mass (less loading for the track substructure)
- high lateral stability (allows increase in rise in curves by up to 25 %, which can show in smaller curve's radii at unchanged line speed)

- very suitable escape route for the passengers in the event of emergency situations (important especially in tunnels)
- usage of brakes on the eddy currents principle without limitation (advantageous specially at high longitudinal gradient of the railway line and before railway stations)
- lower vibration emission (higher stiffness of structure)

Conversely, considerable disadvantages of the solid travel rail are the following:

- high investment costs
- high requirements in terms of accuracy and quality of construction (can not be repaired)
- the geometrical position of track adjustability is limited (as the rule up to 25 mm in vertical and up to 5 mm in the traverse direction)
- inclination to affect the stability of the track substructure (any instability must be excluded for the full lifetime of the settlement, which is difficult to meet in the case of earth mass, therefore the solid-bed track is mostly used on bridges and in tunnels)
- high noise emissions (the solid-bed track design must be notably supported by the anti-noise protection elements)
- in case of an extraordinary event leading to derailing and which will cause failure of the structure an extensive and costly repair will have to be carried out.

Switch construction

Another part of the HSR that is going through a lot of innovations are the switch assemblies. It is mainly given by the operating requirements due to higher train speed into the deviation and as smooth travel as possible in the straight and the deviated directions (without interruption of the travelled on rail surface). As the result of higher speed, which the switch into deviation allows, the curves radii in the deviation branch are bigger, which makes also longer the switch blades which in turn leads to increased construction length of the switch. This also leads to higher number of switch-point machines and the switch blades' locks with connecting rods.

On switches which allow low speed transit through deviation, the branch-off is designed only in the shape of a circle, so at the point of its beginning and its end a sudden change of curvature occurs, causing a growth in jumps / reduction of the lateral acceleration acting on the passing through train. This affects negatively the travel comfort as well as all parts of the switch assembly. These undesirable effects are eliminated on the narrow switches by inserting a transition curve (usually in the shape of a clothoid) into the branch track of the switch.

Another possibility to improve the train travel comfort through a switch is to construct a movable nose crossing, which will remove the interruption of the travelled over surface of one rail line during the travel through the switch. By this provision the need for guard rails at such switch falls away. Perfect contact between the wheel and the rail at the switch can be also achieved by preserving the rails' lateral incline against the sleeper in the same way, as it is done with the conventional rail. This is achieved by shaping the head of the rail to such an extent that its shape corresponds to its placement in the incline while its mounting to the sleeper of the switch remains horizontal.

Peculiarities of the high speed railway lines when compared to conventional railway lines

The air pressure increases significantly around the fast travelling trains on the HSRL. To reduce the air pressure acting on carriages when they pass each other on parallel tracks, wider track centre distance in the open line is designed (at least 4.2 m, but for example in Germany 4.7 m); tunnels are shaped correspondingly, with larger cross-sections of the tunnel tubes, and at the stations the platforms are spaced adequately apart. In terms of the TSI principles the passenger must be prevented to come close to the rails on which the train travelling at the speed of 250 km/h and higher will be passing (some administrators of the infrastructure are lowering this speed to 200 km/h). It is theoretically possible to design barriers for such platform, which would be removed when the train stops for the passenger to board and to disembark the train (for example similarly to the arrangements made on the unmanned metro), but in practice this requirement is resolved for the time being in such a way that station platform are designed only at the passing track, on which the passing through the station train is allowed at lower speed.

With regard to the HSRL safety operation requirements and the high line speed, all crossings with the transport routes are resolved as a rule as elevated crossings (quiet surface communications can be cancelled), and to prevent entry of unauthorised persons and fauna on the railway line it is necessary to fence it along its whole length.

7. Conclusion

With the development of technology, commerce and tourism in the 2nd half of the 20th century, most countries of the world experienced fast growing demand for transport and increasing demands of the travellers and transporters for transport reliability. The automobile and the air transport operators adapted to the requirements in a versatile manner. The rail transport also had to start offering their customers higher travelling speed, reliability, sufficient range of connections, comfort and complex range of services. During this revival of the rail transport it was consequently recognised among other things that certain track sections' capacities are not adequate, and also discovered that their routing and technical parameters are inadequate as well. This gradually led in many countries round the world to radical modernisation of important rail routes and development of new high speed railway lines.

Construction of the HSR has been considered seriously few times also in the Czech Republic (and in former Czechoslovakia). So far, preference has been given to modernisation and optimization of the existing rails, which is certainly needed and through which the previously neglected maintenance was caught up with, moral lagging of the railway line infrastructure behind the technical progress of its times and the customers requirements have to be also attended to. But the modernisation as presently perceived can not in the long term and on a bigger scale satisfy the needs of the inhabitants and visitors of the Czech Republic in Europe without national borders, neither it is able to compete with other types of transport, which are much more harmful to the environment. It must be also mentioned that the modernisation of the conventional rails is not in contradiction with the construction of the new HSR, but rather to the contrary – they suitably complement each other. The future rests in two railway networks, each with different functions, but closely and mutually cooperating.

The Czech Republic occupies a strategic position in the centre of Europe, which predestined it to be also the centre of big events and a crossroad of important routes. But if it does not react fast to the changes taking place in the rail transport in the neighbouring countries (especially in Germany and Austria), which are, among other things, substantially increasing the qualitative and capacitive level of their railway line infrastructure, the natural potential of the advantageous position will remain unused, which will reflect in the declining level of the whole economy.

In closing it is appropriate to point out the reality of the Czech Republic: In the field of the road infrastructure, big portion of the finances is allocated for construction of new roads (especially highways). By contrast, in the rail transport area it happened so last time (apart from the investment initiated by other activity) during the construction of the railway line

Brno – Havlíčkův Brod, completed shortly after the second World War; in any other instances it was, at the most, by-pass constructions of certain track sections.

8. Literature

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