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THE PRESENT CONDITION AND PROJECTION OF CONSTRUCTION OF RAILWAY NET OF THE DANUBE-MORAVA CORRIDOR

Abstract: The railway net of the Danube-Morava corridor, together with the road net represent the central section of the Pan-European transport corridor X. According to the traffic and economic standards, the railway net represents the second main traffic direction of this corridor as the area-functioning system of the territory of Serbia. Main railway lines have favourable positions as they are located along prominent geographical features, namely river valleys thus enabling considerable flow of goods, passengers and information.

The paper presents some characteristics of the present condition of the railway net, its functioning and safety, with certain ideas of its future construction and expected exploitation till 2015. Traffic infrastructure represents the initial factor of overall development of a state and its connection with the surrounding countries. It is considered to be of strategic importance for a country to built railway net. Improvement and additional construction of railway lines is of the greatest priority for the purpose of enlargement of overall mobility and quality of life of population, to make urban areas closer, to improve connections, functions, efficiency and level of services of railway system, reduction of negative influence on other economic systems and human environment, better safety, etc.

Key words: Pan-European transport corridor X, Serbia, Southeast Europe, Railway net

Introduction

Railway traffic is another main type of traffic, exclusively connected to railway net that is more reliable and accurate, is of greater capacity and considerable speed and less dependant on weather conditions. Permanent technical progress in constructing the railway net is essential as the railway traffic, in spite of constant reduction, remains the main and most economical carrier of majority of goods on land, especially on longer destinations. Due to mentioned reasons, railway net has the largest length and density in Europe, but the capacity and condition of railway net in the South-East Europe is less efficient then in Central or Western Europe.

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Railway net of the Danube-Morava corridor is parallel and intersects with the road net. Already constructed tracks and its development perspectives could be viewed from a number of angles, as are: condition of already constructed tracks, position of routes, gauge and number of tracks, traction system, capacity, projected speed, axle load, level of maintenance, signaling system, level of crossing, and the similar. Exploitation of railway net and its safety could be seen from daily or annual turnover of trains, freight and passengers, estimation of delay, number of accidents, etc.

Concerning the traffic infrastructure, central consideration of Spatial Plan of the Republic of Serbia is of already constructed and defined directions of the Danube-Morava corridor, which are of strategic importance for construction of highways and high-speed lines. In that respect one of the main priorities is to establish final position of routes of railway net, compliance with other elements of traffic infrastructure, its technological modernisation, set up of standards and the similar, with respect to preservation of human environment.

Space position and condition of railway net of the Danube-Morava corridor

Condition of already constructed railway net on the Balkan Peninsula is far behind then is the case in Central or Western Europe, mainly due to lower economic development of the Balkan countries and great destructions of railway net during the Second World War. The first railway line on the territory of Serbia was constructed by the Turkish Empire on route Thessalonica–Skopje–Kosovska Mitrovica (1869–1874), almost half a century later after the invention of the first steam locomotive in Great Britain, in 1825. Only after the Berlin Congress, as obligation of the Great Powers to invest foreign capital, Serbia constructed its first railway line from Belgrade to Nis in 1884. Next year, sections towards Pirot and Vranje were constructed, and only after the completion of those sections, Turkey built a part of railway from Skopje to Vranje thus completing line Belgrade–Nis–Skopje–Thessalonica on the Morava–Vardar corridor.

Before the First and between the two World Wars, only enlargement and better connecting of existing railway net was done, but during the Second World War railway net was severely damaged, and there was a considerable loss in number of vehicles. During the Second World War main target of reconstruction was to revitalize railways. “Railway traffic was the main means of transport, participation of which in transport of goods and passengers during pre-war period and the first post-war years, amounted to 80% of overall Yugoslav turnover" (Pavicevic, 1990). Fast tempo of construction lasted till 1953, in years to come it was slower as the construction of roads was given advantage. Practically, the greatest part of railway net in Serbia is half a century old.

Density of railway network in Serbia has not changed significantly in the last quarter of the 20th century. According to the analysis of Jovan Dinic (1976), it was 3-5 km/100 km^2, which is similar to that in other former Yugoslav republics, as well as in Romania, Bulgaria, Spain, Portugal and Sweden. Compared to the density of railway network in some other European countries, it is almost three times smaller than in Great Britain, Germany, Switzerland, Belgium, Denmark, Czech Republic and Slovakia, where the density is greater than 10 km/100 km^2, and two times smaller than in France, Italy, Austria, Hungary, Poland and Ireland (5-10 km/100 km^2). Density of railway network in Serbia is a bit greater than in Greece, Norway and Finland (1-3 km/100 km^2), as well as than in Albania, Turkey and the countries of the former Soviet Union (less than 1 km/100 km^2) (Dinic, 1976).

In the municipalities of the Danube-Morava corridor (fig. 1), density of railway network is 5.3 km/100 km^2, which is above the mentioned average. The following railways pass through these municipalities: a segment of the Pan-European transport Corridor X, Lower Danube segment which belongs to the Corridor VII, and the inner transversal segment along the river Zapadna Morava.

Condition of railways of Pan-European corridor X, being old and dilapidated, is in fact the worst one in the Danube-Morava corridor, on lines that led towards the Upper Danube, Sava, Great Morava and Nisava axes. According to Technical Secretariat for Corridor X from Thessalonica, for all sections, except the South Morava axis, from Nis to Presevo towards Skopje, reconstruction is needed. Serbia initiated a project of high-speed lines long time ago, as the best solution for such a situation. In the surrounding countries, i.e. from the state border to Budapest and Sofia, as well as on sections from Veles to Thessalonica, railway net is in the similar condition.

As it is projected in the Spatial Plan of the Republic of Serbia "High-speed lines represent additional construction on double-track lines of standard speed which make a base of railway traffic in the Republic. High-speed lines comply with the railway net of high-speed lines in Europe, and basically they go along the corridors of existing railways.

Planned high-speed lines:

1. Belgrade–Novi Sad–state border–Hungary (E–85);
2. Belgrade–Nis (E–85 and E–70);
3. Nis–Presevo–state border–FYR Macedonia (E–85);
4. Belgrade–Pancevo–state border–Romania (E–66)
5. Nis–Dimitrovgrad–state bordar–Bulgaria (E–70);
6. Belgrade–Sid–state border–Croatia (E–0)" (Spatial Plan of RS, 1996).

All planned lines, except for direction towards Romania, are located on the Danube-Morava corridor; namely they represent a part of Pan-European corridor X.

Gauge and number of tracks. All railways of the Danube-Morava corridor are single-track lines (1435) but differ in number. Double-track lines are on directions: from Belgrade to Tovarnik (state border with Croatia), from Velika Plana to Nis, except section in Stalac gorge, from Stalac to Zitkovac. All other railways are single-track lines. Special characteristic from Belgrade to Velika Plana are two spur single-tracks via Mladenovac and Mala Krsna. All railways on interior axes of the West Morava and Lower Danube are also single-tracks. In the surrounding, on Corridor X, in FYR of Macedonia, Greece, Bulgaria and Hungary, are single-track lines, while in Croatia are double-tracks.

With the reconstruction of the railways additional track should be constructed on all single-track lines of the Danube-Morava corridor. As projected by the Spatial Plan of the Republic of Serbia "Corridors of all existing and planned railway net of the Republic of Serbia are defined as corridors of double-track electrified lines" (Spatial Plan of RS,1996).

Besides mentioned planned high-speed lines, the following directions for additional construction are planned: Pancevo–Zrenjanin; Belgrade–Valjevo–Pozega; Lapovo–Kragujevac–Kraljevo; as well as along the wider railway ring round Belgrade junction: Batajnica–Ostruznica–Ripanj–Mali Pozarevac–Mala Krsna–Smederevo–Kovin–Pancevo–Batajnica. The main purpose of constructing double-track railways is to follow the main axis of territorial integration and regional development as well as development of centers of aimed polycentric concentration of industry.

Types of terrain, Geological configuration and relief, besides economic and geographical dispersion of production systems and market, have the most important influence for the construction of railways and facilities that follow. As said by J. Dinic "Along with it there is a considerable similarity with road traffic, but there are differences, especially concerning the maximum slope.

Namely, the slope with road traffic goes up to 18%, while at railway its value does not exceed 4.5%" (Dinic, 1999). Railway lines of the Danube-Morava corridor are located at the best possible terrain. Flat type of terrain prevails on all main directions, as they are in the plain of Vojvodina and valleys of the rivers Sava, Velika and Juzna Morava, with exception of two smaller hilly sections: Belgrade–Velika Plana and Nis–Dimitrovgrad. As in the case of road net, this connection of flat terrain makes the main lines and enables high relocation of corridor on which other railway net relies. Hungary and Croatian have the similar flat routes, while in other countries that are connected by the Pan-European corridor X, mainly hilly type of terrain prevails.

Traction system of locomotives is electric on all main lines, except on section Nis–Dimitrovgrad. This section, as well as railways on interior lines, has diesel traction system, with projection of transferring to electric system, due to the permanent rise of a price of diesel fuel and ecological damages caused by diesel traction system. On the other side, electric traction system enables faster modernization that includes increase of speed and automatic operation of this kind of traffic. Electrification of railways is one of the priorities in construction of railway traffic of Serbia even on the railway lines out of the corridor, where economic investment feasibility exists.

Electric traction system of the Danube-Morava corridor is connected with the same traction system that operates in the neighboring countries, except in Bulgaria, where traction system is partially electric, and of diesel system.

Railway capacity, expressed by number of trains per day shows average utilization of railways in comparison to railways in the surroundings. So, 100–150 trains per day operate on sections: Belgrade–Tovarnik and Velika Plana–Nis; then 70–100 trains on sections Belgrade-Velika Plana and Belgrade-Horgos; and 40–70 trains on sections Nis–Presevo and Nis–Dimitrovgrad (http://edessa.topo.auth.gr/X/X). In comparison to surrounding countries it is considerable less then in FYR of Macedonia, which does not have, and Croatia that has double- track railway system. With modernization of railway system and better organization of traffic it is possible to double, and even triple the railway capacity, as is expected to be achieved in future in the surrounding countries.

Maximum projected speed on all main lines of the Danube-Morava corridor is 110-120 kph, except on section Belgrade–Mala Krsna–Velika Plana, where maximum projected speed is 100 kph. With all planned reconstructions and laying of new tracks, the following speed is anticipated: Belgrade–Horgos 250 kph; Belgrade–Tovarnik 160 kph; Belgrade–Nis 130–140. On section Nis–Presevo remains 110–120 kph, and towards Dimitrovgrad 100 kph (http://edessa.topo.auth.gr/X/X). With the complete realization of project “High-speed lines” maximum speed would be equalized depending on the configuration of terrain and would fit into speed system of railway traffic on Corridor X. Surrounding countries, also have similar plans regarding the increase of maximum speed of railway traffic.

Allowed weight on axis of railway net in Serbia is 22.5 t, which is maximum amount for the majority of railways on Pan-European corridor X. Such weight on axis is on railway lines in Croatia, Slovenia and Austria. On railways in FYR Macedonia and Greece and through Hungary from state border to Budapest, allowed weight is 20 t. Exception from maximum load on axis in Serbia is on section Belgrade–Mladenovac–Velika Plana, where projected weight is 20 t. In future reconstruction and construction of new railways greater load on axis will not be permitted.

Level of maintenance of railways of the Danube-Morava corridor is average one, even law on section Belgrade-Mladenovac–Lapovo, which is characteristic for other Balkan countries as well as in Hungary. Reasons for this should be found in insufficient economic development of the South-East Europe in comparison to other developed parts of Europe. There is always a lack of financial support for its maintenance. Regarding the importance of this European transport corridor it is necessary, besides its construction, also to provide necessary financial means for its investment maintenance.

Signaling system is in accordance with the electrification of railways, it is electric on all sections, except on spur track Nis–Dimitrovgrad, where it is mechanical. Such system is functioning on railways in surrounding countries.

Number of crossings at level is basic indicator of traffic efficiency and safety of railways. It varies on certain sections depending on the category communication lines on which it crosses. Majority of crossing is on section Nis–Presevo, 140–150, while on others it is three to four times less. So, on sections Lapovo–Nis and Indjija–Horgos there are 40–60 crossings; then, Belgrade–Tovarnik, Belgrade–Mladenovac–Lapovo and Nis–Dimitrovgard, 20–40 crossings; and finally on spur track Belgrade–Mala Krsna–Lapovo it is less than 20 crossings at level (http://edessa.topo.auth.gr/X/X). Similar railway crossings at level are in FRY Macedonia and Croatia, it is somewhat greater in Hungary, and smaller number of crossings in Bulgaria.

Present condition of already constructed rail, speed and other parameters of railway net represent an objective factor of functioning of railway traffic in the Danube-Morava corridor.

Passenger trains frequency per day is indicator of flow and dynamics of traffic, which is different on different sections. So according to the Technical Secretariat of Corridor X from Thessalonica, average frequency per day from Belgrade to Tovarnik is 70–90 trains; from Horgos to Nis for two categories less, 20–40 trains; from Nis to Presevo and Nis to Dimitrovgrad even smaller, 10–20 trains (http://edessa.topo.auth.gr/X/X). Train frequency per day in the surrounding countries is somewhat higher than in Serbia.

Passengers' flow in railway traffic is characteristic for industry-developed countries as are Japan, Germany, France, etc. not only on intercity lines but also in suburb traffic. We expect the same increase of flow together with the spreading of cities and urban areas. In that respect the Spatial Plan of the Republic of Serbia projects construction of railway junctions: Belgrade, Nis, Novi Sad, Subotica, Zrenjanin, Pancevo, Vrsac, Ruma, Valjevo, Kraljevo, Lapovo, Kosovo Polje, Zajecar, Pozega, Sabac, Mala Krsna, as well as solutions for railway traffic in towns: Kragujevac, Sombor, Pozarevac, Smederevo, Nis, Krusevac, Cacak, Loznica, Kikinda, Senta, Leskovac, Vranje, Sid, Sremska Mitrovica. Majority of these towns are within the Danube-Morava corridor.

Freight trains frequency per day as a whole is less than passenger trains. On sections Belgrade–Tovarnik it is 20–30; Horgos–Nis 10–20; and Nis–Presevo and Nis–Dimitrovgrad 5–10 trains. On the territory of FYR Macedonia that number is higher 30-40, and on territory of Croatia it is 5–10 trains (http://edessa.topo.auth.gr/X/X).

In basic 2000 year, annual frequency per day of all passenger and freight trains on mentioned lines was as following: Belgrade–Tovarnik 80–100 trains; Horgos–Nis 40–60 trains; Nis–Presevo and Nis–Dimitrovgrad 20–30. According to middle and higher scenario till 2015 year, for railways of the Danube-Morava corridor expected increase should be on sections Belgrade–Tovarnik and Subotica–Belgrade, over 100 trains per day; and on section Nis–Presevo, 30–40 trains, while on other sections it will remain the same (http://edessa.topo.auth.gr/X/X).

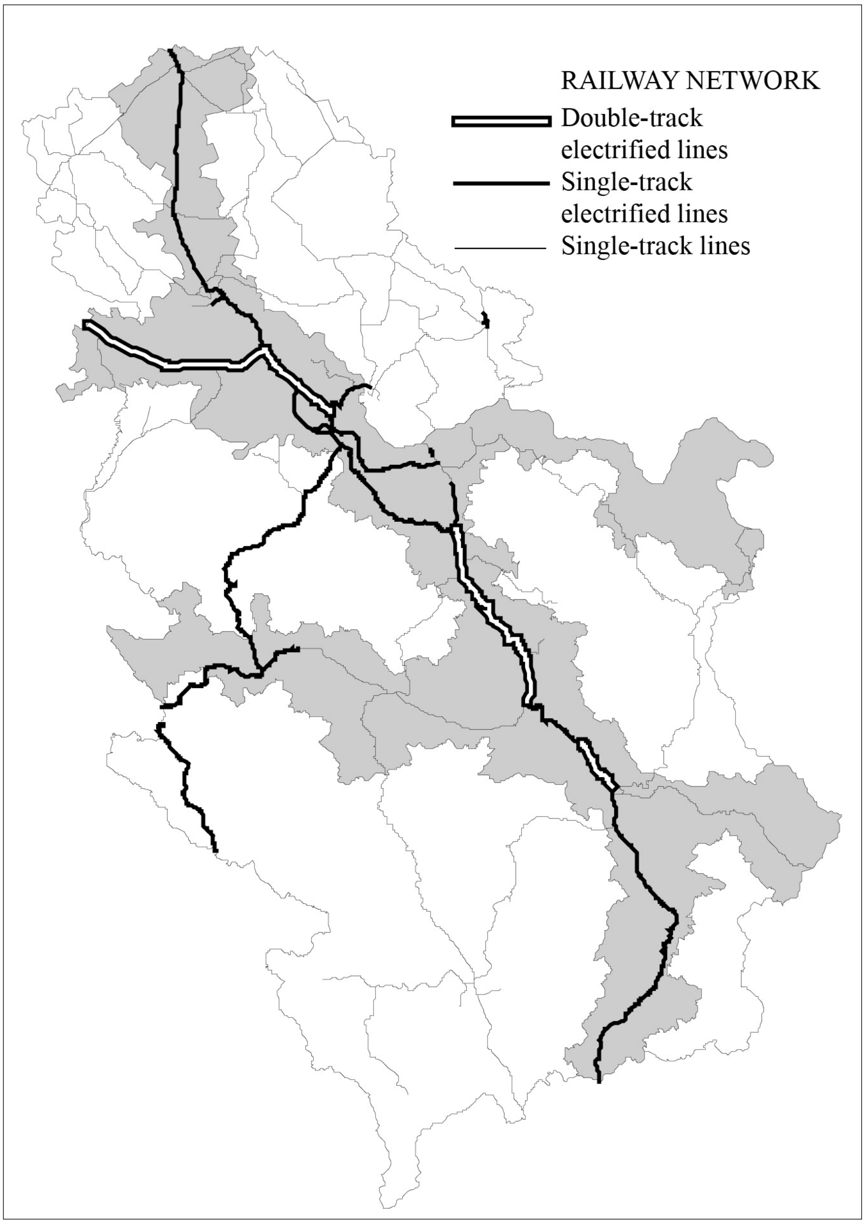

Fig. 1. Railway network in the municipalities of the Danube-Morava corridor
Functioning of railway traffic of the Danube-Morava corridor

Annual number of passengers on main railway section Belgrade–Nis–Presevo is 2–3 million; Belgrade–Tovarnik 3–4 millions; Belgrade–Horgos and Nis–Dimitrovgrad 1–2 million of passengers. Such flow of passengers is similar in surrounding countries, while, e.g., on railway section Novska–Zagreb 5–6 million of passengers. Presented figures show lower level of transport of passengers in relation to possibilities of passenger's use of railway that would amount to 20 million of passengers (http://edessa.topo.auth.gr/X/X).

Annual transport of freight, in proportion, is similar to transport of passengers, per railway sections. So on railway section Belgrade–Nis annual transport is 2–3 million of tons of goods; Belgrade–Tovarnik 3–4 million of tons; Belgrade–Horgos, Nis–Presevo and Nis–Dimitrovgard 1–2 million of tons. The similar is in the surrounding countries, although it would be possible to transport up to 30 million tons (http://edessa.topo.auth.gr/X/X).

These figures of passenger and freight transport, on the existing railway lines in South East Europe, show that there is transit of railway to road traffic. So it would be of great importance to have considerable reconstruction and modernization of railway system.

Annual crossing of passenger trains at cross borders is the highest on Hungarian border, 8.700–8.800 trains. On Croatian border it is only 4.000–4.100, and on border with Macedonia and Bulgaria the number is even smaller, 2.900–3.000 of passenger trains (http://edessa.topo.auth.gr/X/X). These figures, as in the case of road traffic have shown the importance of Horgos border as a gate to Europe, especially that Hungary joined the European Union in 2004.

Annual crossing of freight trains at cross borders is performed on double-track lines through Croatia, so in Tovarnik there are 11.300–11.400 train crossings. On the other side railway net of the Danube-Morava corridor, in Presevo, annual crossing is 8.000–8.200, and in Dimitrovgrad 5.500–5.600 of freight trains (http://edessa.topo.auth.gr/X/X).

Average delay of passenger trains at cross borders is very high. On cross borders with Hungary, FYR Macedonia and Bulgaria it is 61–70 minutes, while from the side of Macedonia it is 21–30 minutes, and from Bulgarian side it is 31–40 minutes. Over border with Croatia, average delay from Serbian side is 41–60 min, and from Croatian side it is 21–30 minutes (http://edessa.topo.auth.gr/X/X).

Average delay of freight trains at cross borders is drastically higher in comparison to passenger trains. So, for example, over the cross borders with Hungary and Bulgaria that average is 171–200 minutes, and over border with FYR Macedonia and Croatia 150–170 minutes, although from Macedonian side delay is smaller, 70–80 minutes, and from Croatian 50–60 minutes (http://edessa.topo.auth.gr/X/X).

Average speed of passenger trains from state border with Hungary and Croatia via Belgrade, Mala Krsna and Nis to border with FYR Macedonia is 50–60 kph, while from Nis to Dimitrovgrad, as well on section Belgrade–Mladenovac–Lapovo 40–50 kph (http://edessa.topo.auth.gr/X/X).

Average speed of freight trains is higher in comparison to passenger trains on all sections as there is no deceleration or stopping on stations for passengers to get on or off the train. On part of railway line Lapovo–Nis, that average is 60–70 kph; on sections Belgrade–Lapovo and Belgrade–Tovarnik 50–60 kph; while on sections Nis–Presevo, Nis–Dimitrovgrad, Belgrade–Mladenovac–Lapovo, 40–50 kph, and Indjija-Horgos 30–40 kph (http://edessa.topo.auth.gr/X/X). Average speed of passenger trains is almost the same as train speed in surrounding countries, average speed of freight trains is once or twice higher then the average in FYR Macedonia, Bulgaria and Hungary.

Annual number of railway accidents per kilometer is less then in road traffic, which proves the greater safety of railway traffic. Yet, on different sections that average varies. It is the greatest on section Belgrade–Tovarnik 1.00–1.10 accident; then Indjija–Subotica and Lapovo–Nis 0.50–0.60 accident; Belgrade–Mala Krsna–Lapovo 0.20–0.21 accident; and it is the smallest on sections Nis–Presevo, Nis–Dimitrovgrad and Belgrade–Mladenovac–Lapovo 0.10–0.15 accident per kilometer. In FYR Macedonia number of accidents per kilometer is below 0.10 and in Hungary and Bulgaria 0.40–0.50 (http://edessa.topo.auth.gr/X/X).

Summary

The paper analyses railway net of the Danube-Morava corridor, and together with the road net it represents the central section of the Pan- European transport corridor X. Spatial position, existing condition of railways and development projection are presented through: already constructed railway net, actual state of railways, gauge and numbers of tracks, types of terrain, traction system, railway capacity, maximum projected speed, allowed weight on axis, level of maintenance, signaling system, number of crossings at level, etc.

Besides these, it is analyzed the functioning of the Danube-Morava corridor through: frequency of passenger trains per day, frequency of freight trains per day, annual number of passengers, annual transport of freight, annual crossing of passenger trains at cross borders, annual crossing of freight trains at cross borders, average delay of passenger trains at cross borders, average delay of freight trains at cross borders, average speed of passenger trains, average speed of freight trains, annual number of accidents per kilometer, etc.

As traffic infrastructure represents the initial factor of overall development of a state and its connection with the surrounding countries, it is considered to be of strategic importance for a country to built railway net. As is the case with roads, improvement and additional construction of railway lines is of the greatest priority for the purpose of enlargement of overall mobility and quality of life of population, to make urban areas closer, to improve connections, functions, efficiency and level of services of railway system, reduction of negative influence on other economic systems and human environment, better safety, etc.

In that respect, the main steps to be taken is to set up final position of railway routes, realization of good communication among border connections and thus reducing the time of stops at the border crossings, built up new or reconstruct old junctions, finding out of new routes or detours around greater city agglomerates, with reservation of areas for elements of traffic net and its connecting and crossing, and at the same time taking care of ecological protection of corridor.

Although it is of importance for development of the country, the Danube-Morava railway net represents about one third of overall Pan-European transport corridor X. For the improvement and adjustment of this net with the international standards, regulations and recommendations, both domestic and foreign financial investment is needed, as it was the case at the beginning of construction of first railway lines in Serbia, at the end of 19th century.

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