



RAILWAY MODERNIZATION PROJECTS IN THE REPUBLIC OF SERBIA AND CONNECTION WITH THE SURROUNDING COUNTRIES

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Abstract

Railway modernisation is a broad term that can refer to various projects and initiatives aimed at improving the efficiency, safety, and capacity of railway systems. This may include upgrading the existing infrastructure, introducing new technologies, and expanding the network to new areas or building new infrastructure and equipment in accordance with the systems to which it will be connected. Railway Sector Modernization Project for Serbia aims to improve the efficiency and safety of Serbia's rail network and enhance the environmental sustainability of Serbia's transport system. The paper presents the key parameters of railway modernization from the point of view of traffic, construction and electrotechnical expertise and the effects/connections on the railway network of the countries surrounding the Republic of Serbia. Modern infrastructure for a speed of up to 200 km/h and modern vehicles offer a new quality in passenger traffic and will make it possible to shorten the travel time by train from Belgrade to Budapest. Planned route of the high-speed railway line Belgrade - Niš for a speed of up to 200 km/h (corridor 10) and the bypass railway line Beli Potok-Vinča-Pančevo for a speed of up to 120 km/h (connecting the infrastructure capacities of the Belgrade railway node with the railway lines Pančevo-Vršac and Pančevo-Zrenjanin) have a significant role in the modernization of Serbian railway network not only in the traffic context, but also in all segments of the electrotechnical profession. The implementation of advanced signalling systems, such as the European Train Control System (ETCS), promises increased operational precision and reduced travel times, contributing to a more competitive and sustainable transportation sector. In the context of regional connectivity, Serbia is also actively engaged in collaborative initiatives with surrounding countries on standardization and integration of signalling systems, ensuring smooth cross-border rail traffic and facilitating the movement of goods and passengers within the broader European network.

Keywords: modernisation, railway network, high speed, ETCS

1 Introduction

Serbia's international road, railway, and inland waterway networks are connected to the broader Western and Central European transport corridors, as well as to intercontinental routes linking Central and South-eastern Europe with the Middle East, Asia and Africa. Serbia's vision for the transport sector is built around Serbia's ambitions for EU accession and meeting the standards to achieve this. This includes connecting communities in a safe and reliable manner while protecting the environment by reducing air pollution, noise and GHG emissions through more diverse and "green" means of transport.

A key part of the transport strategy is connecting to the EU Trans-European Transport Network [1] (TEN-T) and all that this entails in terms of physical infrastructure, standards, participation in EU transport markets [2], cross border trade, and improved inter-modal transport. Railway infrastructure modernization is essential to address various cross-cutting performance issues. Decades of low and non-strategic investments, outdated management structures and practices, and neglect of maintenance have led to serious deterioration of the network infrastructure, and low service quality. Financial, institutional and operational reforms implemented so far have laid the essential foundation for railway modernization and shall be followed up with significant capital investment to improve traffic within the country, strengthen and accelerate connectivity with surrounding countries and create public benefit. Overcoming all the aforementioned challenges requires a comprehensive approach that includes modernization of both infrastructure and rolling stock, improvement of organization and management, as well as investment in new technologies to increase safety. Effective addressing of these problems will not only improve the reliability and attractiveness of railway transport in Serbia, but will also contribute to increasing the country's competitiveness as a transport hub in the region.

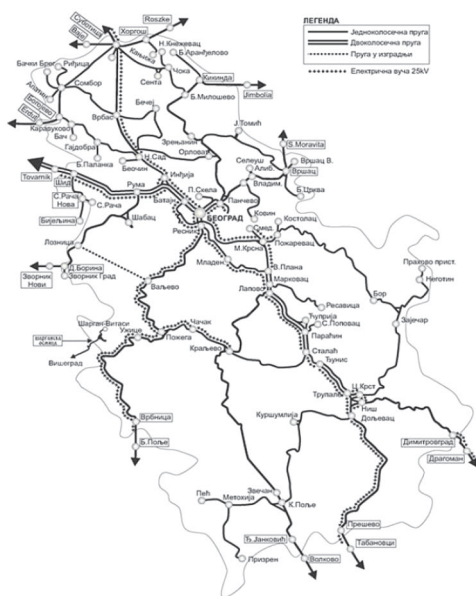


Figure 1 Serbia railway network

2 Overview of current state

Currently, the state of railway modernization and connection with countries in the region should be viewed from the aspect of traffic, infrastructure, electrotechnical facilities (signalling-interlocking and power supply devices), in order to fulfil the next steps within the set goals and vision that we are following. The total structural length of the standard-gauge railway lines on the territory of the “Infrastructure of Serbian Railways” JSC according to the data of the Network Statement [3] at the end of 2022 is 3,333.4 km, out of which 3,044.7 km are single-track and 288.7 km are double-track lines. Out of the mentioned lengths, 1,744.4 km are the main lines, and 1,589.0 km other lines (Figure 1).

2.1 Infrastructure

On the railway lines managed by the “Infrastructure of Serbian Railways” JSC there are 956 bridges with a total length of 40 km, 3,803 culverts, 334 tunnels with a total length of 153 km and 2,132 level crossings, and with 5,315 switches installed. The total length of trackside and station tracks is 5,124 km. Designed condition of the railway network in the Republic of Serbia enables the traffic of railway vehicles weighing from 12 t/axle to 22.5 t/axle, of which on 43.05% of the total length of the tracks, the permissible axle load is 22.5 t/axle, which represents an obstacle to the further growth of railway traffic. Significant reduction of the maximum permitted speeds on the railway lines in the past period has been a consequence of the long-term failure to provide funds for the regular maintenance of infrastructure elements, so it can be said that the railway infrastructure has a very low level of technical reliability and technological availability. As a consequence of the permanent way and substructure elements poor technical condition, as well as due to the performance of works that require a speed reduction provided for in the timetable, and in order to preserve traffic safety, a significant number of slow runs are being introduced.

2.2 Electrotechnical facilities

Total length of tracks on electrified railway lines is 2,263 km, of which the length of electrified lines (open lines and main transit tracks) is 1,546 km. On the electrified railway lines, a single-phase alternating electric traction system of 25 kV/50Hz is used. The national automatic train control system is INDUSI I-60, and the European train control system (ETCS) level 2, as well as modern railway telecommunication GSM network (GSM-R) are installed on the Belgrade-Novi Sad railway section.

Insufficient financial resources for maintenance in the past period affected deterioration of the technical condition of the system as a whole, so individual facilities were brought to a critical state. Signalling-interlocking and telecommunication devices are over 40 years old (in some stations there are even devices that are 60 years old). The overhead contact line, electric traction substations and sectioning posts are about 35 years old, and as prescribed, renewal (overhaul) of the overhead contact line shall be carried out every eight to 10 years.

2.3 Current state of traffic nodes

Development of the railway network shall also include the planning of large railway nodes, primarily Belgrade, Niš, Novi Sad and Subotica. Long-term planning also includes staged implementation that leads to an optimal solution for the functionality of rail transport and meeting the needs of the economy and passengers. The railway renovation and modernization program have included investments that are partly located in the area of railway nodes. Belgrade railway node is the most complex part of the railway system from the aspect of international and regional transport as well as city-suburban traffic. Over a long period of time, there were significant changes in the urban planning of the city, the number of inhabitants and the needs for transportation. Activities on relocation of the railway infrastructure from the Sava Amphitheatre were carried out, but the most significant change in Belgrade’s traffic system was the beginning of metro construction.

Projects of the Belgrade Railway Node define the development of new railway infrastructure, reconstruction and adaptation of the existing infrastructure in accordance with the development of other city transport systems and their optimal integration, especially with the metro system. These processes shall also be followed by the following areas such as: procurement and use of modern rolling stock, national standardization based on the application of technical interoperability standards, modernization of ticket purchasing, and the like.

Implementation of numerous infrastructure projects in the area of the Belgrade Railway Node has commenced:

- Project for the construction of double-track railway line from Zemun polje to Nikola Tesla Airport and the National Stadium, for a speed of up to 120 km/h;
- Project for the construction of new single-track bypass railway Beli Potok - Vinča - Pančevo for freight traffic, for a speed of up to 120 km/h;
- Projects for the construction of new railway stations Karaburma and Makiš of the BG Voz;
- Reconstruction projects of the existing tunnel sections Dedinje, Vezni, Stadion and Vračar and the railway section Pančevački most (Pančevo Bridge) - Pančevo Glavna (Pančevo Main Station).

In addition, it has been planned to expand the network by upgrading new infrastructure on the section Belgrade Center - Batajnica, construction of another technical-passenger station and freight-transportation centre.

Urban and demographic development of the city of Niš has a great influence on the functioning of the Niš Railway Node. Optimum technical-technological solutions of the node is a long-term process of phased planning and realization, and in accordance with spatial and urban planning solutions. Realization of the construction of the railway bypass around Niš has commenced, which shall relieve the central city area of transit freight traffic, reduce the risk of emergency events and accidents, and create a better living environment.

Novi Sad Railway Node has been treated through the Belgrade - Subotica Railway line Modernization Project, which includes the passage of double-track main line through the node, partial reconstruction of the passenger station and introduction of connecting lines to the node. Subotica Railway Node has been also treated through the Belgrade - Subotica Railway line Modernization Project, where dlevelled separation of the main electrified railway line from the connecting non-electrified railway lines and functional separation of the passenger and freight traffic have been envisaged.

3 Modernization targets

Targets of railway modernization in the Republic of Serbia reflect a broader effort to improve the efficiency, safety and competitiveness of the railway sector, as well as to encourage its integration into regional and European transport networks. These targets are aimed at addressing existing challenges and exploiting the potential of railways as a key factor of sustainable development. For all the aforementioned projects, modernization targets that have been set are similar and come down to the following:

- Integration into the pan-European (TEN-T) railway corridors;
- Reduction of travel time;
- Strengthening regional connectivity and economic cooperation with surrounding countries;
- Increasing competitiveness of rail transport in international freight traffic;
- Increasing general safety and efficiency of transportation;
- Stimulating economic cooperation and mobility within the country and with surrounding countries (Hungary, Bulgaria, Croatia, North Macedonia);
- Digitization and automation of railway traffic management systems.

This chapter provides a brief description of the most important and ambitious projects that have been initiated or planned in order to modernize the railway infrastructure in the Republic of Serbia. These projects represent key initiatives to improve the efficiency, safety and competitiveness of the railway system.

Construction and modernization of the railway line Belgrade-Novi Sad-Subotica-state border with Hungary is part of an international project that aims to build a high-speed railway line between Belgrade and Budapest. The project is divided into several phases, with the aim of enabling speeds of up to 200 km/h, which would shorten the journey between the two cities to less than three hours. Installation of the ETCS system level 2 has been planned, as well as RDV and GSM-R networks, and traffic management shall be carried out through the centralized traffic control system with the CTC centre in the Belgrade Centre station (Prokop). It is financed through the interstate cooperation between Serbia, Hungary and China, within the framework of the “Belt and Road” initiative. The estimated price of the works is EUR 2.2 billion EUR.

The Project for construction, electrification and modernization of the railway line Niš-Dimitrovgrad-state border with Bulgaria is divided into several phases (bypass railway line + existing railway line, separate civil engineering and electrical works), with the aim of enabling a speed of up to 160 km/h on the new bypass railway line, i.e. up to 120 km/h on the existing Prosek-Dimitrovgrad section. Installation of the ETCS system level 2 has been planned, as well as RDV and GSM-R networks, and traffic management shall be carried out through centralized traffic control system with the CTC centre in Nis. The project is financed from a combination of national funds, loans from international financial institutions (EIB/EBRD) and grants from EU funds (WBIF mechanism). The estimated price of the works is EUR 400 million EUR.

The Project for reconstruction and modernization of the railway line Belgrade-Niš includes complete reconstruction and modernization of the existing railway line between Belgrade and Niš, about 240 kilometres long. The goal is to increase the maximum travel speed to 200 km/h for passenger trains and improve the capacities for freight traffic. Installation of the ETCS system level 2, as well as RDV and GSM-R networks has been planned, and traffic management will be carried out through centralized traffic control system with the CTC centre in Niš. All power plants (overhead contact line, SPEV-stable electric traction facilities) shall be completely modernized. The project is financed from a combination of national funds, loans from international financial institutions (EIB/EBRD) and grants from EU funds (WBIF mechanism). The estimated price of the works is EUR 2.75 billion EUR.

The Project for reconstruction and modernization of the railway line Stara Pazova-Šid-state border with Croatia includes complete reconstruction and modernization of the existing railway line between Stara Pazova and Šid, long about 80 kilometres. The goal is to increase the maximum travel speed to 200 km/h for passenger trains and improve the capacities for freight traffic. Installation of ETCS system level 2, as well as RDV and GSM-R networks is foreseen. All power plants (overhead contact line, SPEV facilities) shall be completely modernized. The project shall be financed from a combination of national funds, loans from international financial institutions (EIB/EBRD), as well as potential grants from EU funds (WBIF mechanism). The estimated price of the works is 700 million EUR.

The project for reconstruction, electrification and modernization of the railway line Niš-Preševo-state border with North Macedonia includes electrification and modernization of the railway line from Niš to Preševo, near the border with North Macedonia, with the aim of enabling a speed of up to 160 km/h. This project is expected to improve efficiency and capacity for international freight traffic. It is assumed that the project shall be financed from the national budget with the support of international loans (EIB/EBRD) and grants. In the coming period, further activities on the implementation of mentioned arrangements are expected.

The project for reconstruction and modernization of the railway line Valjevo-Vrbnica-state border with Montenegro includes complete reconstruction and modernization of the existing railway line between Valjevo and Vrbnica, which is about 210 kilometres long. The goal is rehabilitation of the railway line to the originally designed structural condition from the time of construction in the 70s of the last century, along with modernization of electrotechnical

Although steps have been taken towards better management and organization, there is room to further improve the efficiency of operations and reduce costs. Logistics centres are in the stage of planning and development, which is crucial for the improvement of freight traffic and integration with other modes of transport.

Significant steps have been taken on the connection with the regional and European railway networks, especially through the Belgrade-Budapest railway line project. Cooperation with surrounding countries has been improved, but further strengthening of ties and implementation of joint projects for better connectivity is needed.

Modernization certainly contributes to the reduction of emissions and the promotion of railways as a more environmentally friendly mode of transport, but it is necessary to work further on green initiatives (e.g. introduction of hydrogen or battery-powered trains). Overall, although some progress has been achieved in the realization of modernization goals, numerous challenges remain, such as the need for additional funding, technological improvement and international coordination in the field of new technological regulations (such as joining the EULYNX [4] project for the unification of technical specifications for signalling-interlocking and telecommunications devices at the level of EU countries). Continuation of successful implementation will require an appropriate strategy, investments and cooperation of key actors at all levels.

Modernization of railways is the foundation for the development of a sustainable, efficient and inclusive transport system, which plays a key role in promoting trade, developing tourism and improving regional mobility. By implementing these projects, Serbia not only improves its infrastructure and services, but also contributes to broader regional and international goals of connectivity, economic development and environmental protection.

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