



## CONCEPT OF DEVELOPMENT FOR BELGRADE RAILWAY JUNCTION IN 21<sup>ST</sup> CENTURY

Dragan Božović<sup>1</sup>, Boško Čoko<sup>2</sup>

*1 Faculty of Civil Engineering, University of Belgrade, Serbia*

*2 Institute of Transportation CIIP, Belgrade, Serbia*

### Abstract

Belgrade railway junction is one of the basic transportation systems for the city of 2 million residents and it's positioned between major junctions of southeast European railway network. Given in this paper is a proposal of the basic railway junction development. The concept is based on the research of construction and development of Belgrade junction in the past 125 years. New urban patterns of city development appear as very important junction solution framework. They demand a significant reconstruction of railway infrastructure capacity. New technological solutions in railway traffic, such as high speed train, modern urban and suburban rail systems and links with airport and port terminals, are important part of complete junction solution. Defined in this concept are the major goals and principles of junction development. According to this, the removal of railway infrastructure from river bank and Sava amphitheater is also planned. In order to increase security and capacity a complete flow on main axis and other important lines and systematic construction of double track lines is planned. Separation between passenger and freight trains in the city center is achieved by building marshalling yard in Zeleznik. System of passing through passenger station, and two maintenance depot on both sides of the river Sava is adopted, instead of one main passenger station on the most important line. Entire marshalling of freight train is performed in one gravity sorting yard. Goods work is mostly concentrated in one multifunctional goods terminal. Industrial tracks are planned in those parts of the city in where work with large amount of goods is expected. Motive power vehicle depot and workshops are located in the vicinity of the marshalling yard and passenger stations. Planning and railway junction development were taken into account during this process of finding solution, when development plans are being changed and adjusted. Therefore a possibility of major projects realisation in phases is of essential importance. Presented in this work is the graphic of suggested junction concept solution.

*Keywords: railway junction, solution, transport, intermodal*

### 1 Introduction

Main Belgrade railway station in Sava amphitheatre was built within Belgrade-Nis railway line project during the period from 1881-1884. At the time of putting into operation, Belgrade station had, for that time, a monumental station building. The station had three tracks for train arrivals and departures, two covered platforms, and 15 tracks for freight trains and other needs, goods warehouses and area for locomotives depot and similar. At first this station was connected with Zemun and Nis.

The third line was built in 1899, and it went through Sava's and Danube's right bank by the side of Kalemegdan. In 1935 it was lengthened all the way to Pancevo, over the new bridge, thus establishing the connection of Banat lines with Belgrade.

Sava bridge-Topcider line was built in 1917. A characteristic triangle was formed in that way and it remained a part of all the later junction solutions.

During the further junction development the following lines were included: Topcider – Mala Krsna in 1924, Belgrade – Obrenovac, (a narrow gauge in 1928), and it was removed during the 1960s, another Beograd – Resnik track in 1933, Resnik-Vreoci in 1958 and Batajnica – Ostruznica – Resnik in 1967.

During the World War II the fourth track Beograd – Topcider was built, as well as the second track to the Beograd Dunav station.

Besides, a freight station for train marshaling was built in Topcider, and freight station in Bezanijska Kosa was expanded, which led to total decentralization of junction marshaling work. The first reconstruction solutions for the main Belgrade station date back to 1911. Department for building railways then planned construction of marshaling yard on other site far from passenger and local goods stations located in Sava amphitheatre.

During the period of 125 years of designing and research about 40 different junction solutions were taken into account. The existing Belgrade railway junction is the result of adopted solutions and possibilities of their realization due to fast city development.

### 1.1 A proposal for concept of Belgrade railway junction development

A base for concept and potential for railway junction development are its characteristics and its role in railway network, region and city area. One of the bases of Europe development is the improved European Transport Network. Thanks to its geographical position, in near future Belgrade could become one of the main transport junctions of this network, which would influence the economy development of the city and region.

Belgrade is located on the very crossing of Corridor X and Corridor VII (Danube), which is the basis for multimodal transport junction development. Also Belgrade is the centre of metropolis which includes Pancevo and Smederevo transport nodes.

As an important junction solution frame, there are new urban city development patterns, which require significant railway renewal and city area remodeling.

The railway junction occupies areas of different values in the city or region, which is equally important for passenger and freight junction subsystems. City and regional development should be taken into account when planning the junction.

A very important question is the rationalization of the area occupied by railway infrastructure. The railway junction development is driven by political decisions aiming at social and economical progress, environmental and technological improvement, institutional changes related to Serbian Railways, as well as investments by the interested parties (e.g. Public Private Partnership) etc.

A modern railway junction solution implies: the possibility of high speed train line passing through main passenger station or projected new station for such trains, regional railway system (S-Bahn/RER type), connection points with main roads network, road and railway urban system, and intermodal road, airport and riverport terminals.

## 2 Main goals and principles of junction development in 21<sup>st</sup> century

The proposal for junction solution (Figure 1) is based on the following main goals and principles:

- to enable total passing through the Belgrade railway junction on main line (Corridor X) and other lines in the junction;
- to remove railway infrastructure from river banks, Sava amphitheatre and Topcider Valley to the extent possible;
- to separate passenger and freight traffic within the city area;

- to adopt a clearly defined system of two or more passing through stations on each bank of the river Sava;
- to design the shortest possible lines in the city area and adjust them for intercity and suburban train traffic;
- to eliminate existing level crossing of city roads;
- to eliminate the same level of railway lines crossing;
- to plan building double tracks on each line in the junction;
- to concentrate all the marshaling work on one gravity marshaling yard located as close as possible to the freight traffic centre in order to increase safety level and traffic capacity;
- to concentrate local work with goods on the minimum number of goods stations in the most important industrial zones in the city;
- to connect industrial tracks with significant industrial companies with railway network;
- to concentrate all the work with parcel load on one place in the junction;
- to plan intermodal container terminal at appropriate place in the junction;
- to position maintenance depots and workshops in the vicinity of marshaling yard for freight vehicles;
- to position maintenance depots and workshops for passenger trains on designated sites;
- to assume a high level of automatization and signal and safety devices and telecommunication devices on the lines and stations;
- to realize program of protection and environment improvement;

## 2.1 Freight subsystem

In the proposed solution for Belgrade railway junction the following make the basis of freight subsystem:

- marshaling yard Beograd;
- Makis goods station as central station for dealing with parcels, containers and car loads;
- Karaburma goods station serves primarily the existing Belgrade port;
- Batajnica goods station serves for car load handling operations to and from industrial sidings;

Industrial sidings operation is performed by several stations within the junction.

Main depot of the railway junction is located near the marshaling yard in Makis.

According to the adopted M3 solution and having finished the building of marshaling yard Beograd in Makis in 1970 and construction of railway lines, the basis of freight subsystem of the Belgrade railway junction was established. That provided the whole marshaling work in the junction to be concentrated into only one station. The marshaling and goods station solution which comprises passing through bimodal container terminal, parcel and car loads sidings and warehouses is presented in Figure 2.

Positioning the goods station near the marshaling yard provides rational exploitation of the existing capacities and construction in phases.

After finishing this station the existing goods capacities could be finally transferred from Sava amphitheatre, Donji grad and Dunav station.

By constructing these capacities, the conditions for separating freight and passenger traffic in Belgrade city centre were created.

In accordance with Master plan Belgrade 2021 there is a goods station in Batajnica. We consider this not to be a convenient location, which brings the question of positioning and final number of goods stations in the junction.

The following passenger stations make the basis of passenger subsystem according to the adopted modified solution of Master plan in 1950: Zemun, Beograd (Prokop solution), Novi Beograd and maintenance depots Kijevo and Zemun.

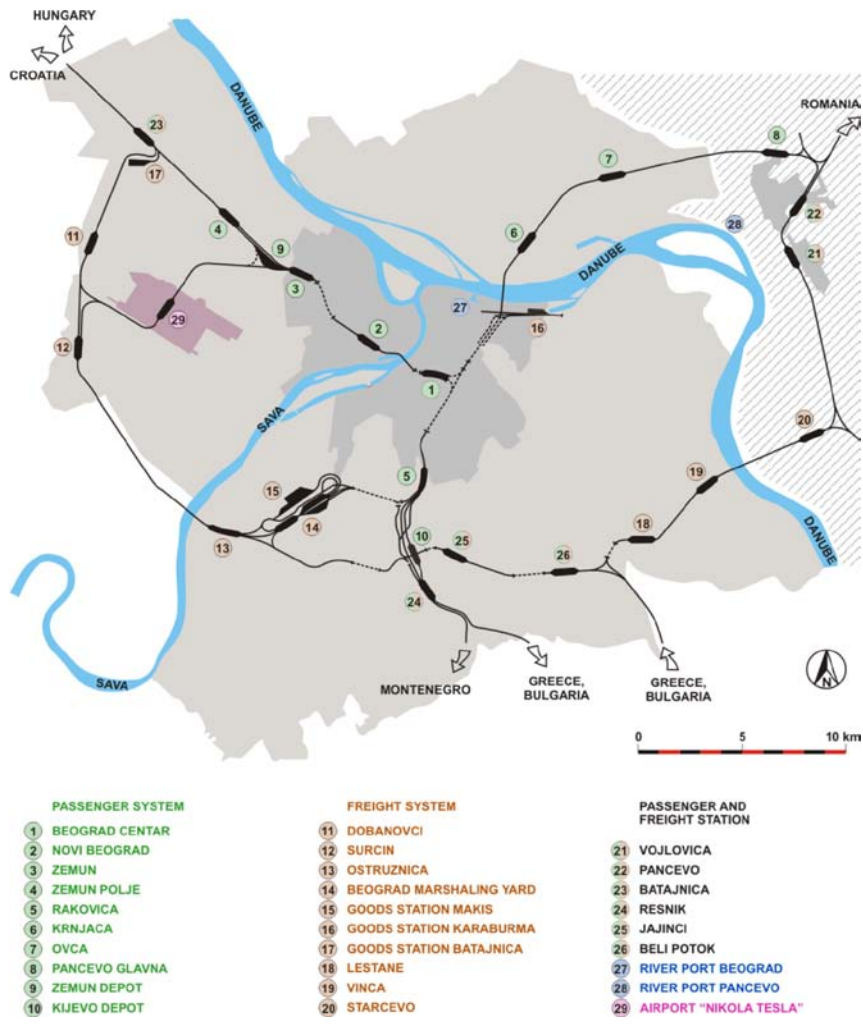


Figure 1 Belgrade railway junction solution

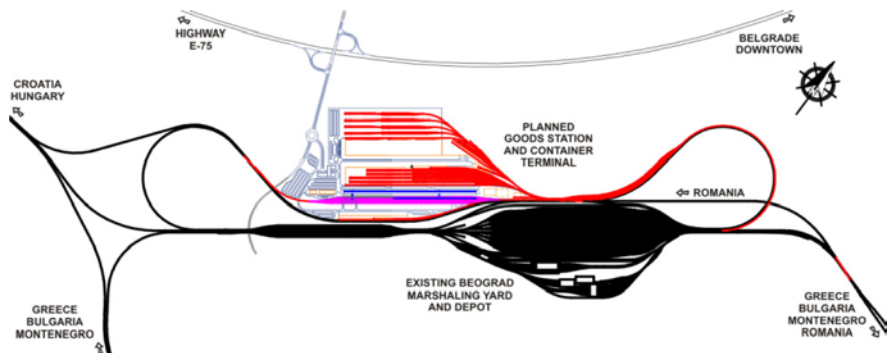


Figure 2 Main capacities of the railway junction freight subsystem

Suburban traffic is carried out in all three directions where there are several stops (Figure 1). According to this solution, the existing main dead end station is replaced with passing through stations in the junction main line (Corridor X). Upon finishing the passenger system the conditions for subsequent clearing of the Sava and Danube river banks and Sava amphitheatre would be provided.

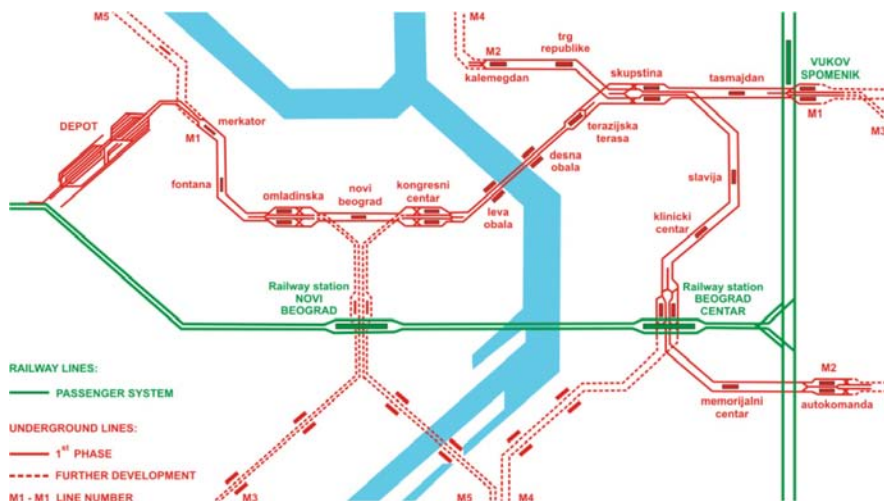


Figure 3 One of the possible solutions for connecting Belgrade railway junction with city metro

## 2.2 Passenger subsystem

The basic passenger subsystem solution from 1970 projected constructing two main passenger stations. A current and very important issue today is defining and assigning tasks between Beograd and Novi Beograd stations. Actually, it is the question of positioning the main passenger station within intercity and international traffic. The correct solution of this issue may only be found on the basis of the detailed comparative analysis, which, up to now, has not been carried out.

Junction passenger subsystem works started in 1974 by constructing the bridge over the river Sava, and then the Vracar and Dedinje tunnels. The main infrastructure was done thus putting the traffic into operation in all directions. To provide regular intercity traffic in the junction it is necessary to build Zemun and Kijevu maintenance depots, as well as the station buildings in Zemun, Novi Beograd, Prokop and Rakovica. The goods stations have not been built yet. One of the most complex problems is to connect Banat with Belgrade railway junction. According to the adopted solution two underground single track tunnels were built from Pancevo bridge and Biblioteka.

The point of separation of the freight traffic from Banat and passenger traffic is just before crossing the line above city highway near the Faculty of Veterinary Medicine.

Passenger traffic continues through Prokop station while the freight traffic continues through Dedinje tunnel to Topcider valley and all the way to marshaling yard in Makis. This solution does not fully solve the problem of the separating passenger from freight traffic in Banat direction. One of the possible solutions is a new line from Beli Potok to Pancevo via Vinca (Figure 1). One of the possible solutions for connecting Belgrade railway junction with city metro is shown in Figure 3. This solution established the direct link of main junction railway stations Beograd and Novi Beograd with metro system.

According to the solution shown in Figure 3 the railway link between city and airport has been made possible through Surcin, Dobanovci, Zemun and Zemun Polje stations. There is a possibility for airport “Nikola Tesla” to be connected from Novi Beograd station. Connection with Belgrade port from Karaburma station is shown in Figure 1. This link can also be established from Krnjaca station, situated on the left bank of the river Danube. Basic frame of the plan for junction solution is being considered.

### 3 Conclusion

One of the bases of further development of Europe is the improved European Transport Network. Thanks to its geographical position, in near future Belgrade could become one of the main transport junctions of this network.

Belgrade is located on the very crossing of Corridor x and Corridor VII (Danube), which is the basis for multimodal transport junction development. Also Belgrade is the centre of metropolis which includes Pancevo and Smederevo transport nodes.

Methodological approach for the solution supports the view that transport and infrastructure systems are the basis for development, and that the possibilities for regional railway systems improvement are the motive for socio-economic development of the city-region.

The solution proposal is based on the analysis of a great number of studies and projects, including domestic and foreign experience and analysis of the possibilities of the Belgrade and region development.

By further development of the solution for the Belgrade railway junction and its construction in stages, a safe, fast and comfortable transport for Belgrade residents can be accomplished. A successful implementation of the adopted junction concept requires permanent and precise work and coordination of national, regional and local government and Serbian railways, as well as partnership with private sector.

### References

- [1] Bertolini, L., & Spit, T.: Cities on rail, FN & Spon, London, 1998.
- [2] Clever, R.: Airport and Station Accessibility as A Determinant of Mode Choice, University of California, Berkeley, 2006.
- [3] Čoko, B. & Božović, D.: Idejno rešenje robne stanice Makiš, Građevinski fakultet Univerziteta u Beogradu, Beograd, 2005.
- [4] Čoko, B.: Idejno rešenje robne stanice Makiš, Modul br.5, pp. 45-47, Beograd, 2005.
- [5] Чоко, Б.: Скраћење времена вожње на постојећим железничким пругама, у Научно -стручно саветовање: Оцена стања, одржавање и санација грађевинских објеката и насеља, Златибор, 29 мај - 01. јун 2007.
- [6] Чоко, Б. и Божовић, Д.: Анализа слободних профила на пругама Железница Србије, VI Научно-стручно саветовање: Оцена стања, одржавање и санација грађевинских објеката и насеља, Дивчибаре, 19 - 22. мај 2009.
- [7] Božović, D i Jokanović, M.: Robne stanice u Beogradskom železničkom čvoru, Međunarodno savetovanje: Projektovanje i izgradnja Beogradskog železničkog čvora, Saobraćajni institut СР, Beograd, 1995.
- [8] Božović, D. i Jokanović, M.: Potrebe i mogućnosti razvoja kapaciteta za robni rad u Beogradskom železničkom čvoru, Savetovanje SANU i grada Beograda: Strategija transportnih sistema u dugoročnom razvoju Beograda, Beograd, 1991.
- [9] Божовић, Д. и Јокановић, М.: Истраживање и дефинисање елемената функционисања слободне царинске зоне у Београду (железнички део), Грађевински факултет Универзитета у Београду, Београд, 1988.

- [10] Direkcija za izgradnju i rekonstrukciju Beograda: Idejna rešenja prve etape metroa Beograd, Beograd, 1981.
- [11] ГФ Београд и Саобраћајни институт ЦИП: Истраживање развојних могућности за повезивање привредних зона са железницом на подручју Београда, Београд, 1983-1986.
- [12] Janjić, S. i Božović, D.: Razvoj ideja o rekonstrukciji Beogradskog železničkog čvora 1880-1995., PINUS 2, pp. 41-62, Beograd, 1995.
- [13] RS: Prostorni plan Republike Srbije, Beograd 1996.
- [14] Urbanistički zavod Beograda: Regionalni prostorni plan administrativnog područja grada Beograda, Beograd, 2004.
- [15] Urbanistički zavod Beograda: Generalni plan Beograda 2021, Beograd, 2003.
- [16] Italferr: General Master Plan for Transport in Serbia, Final Report, 2009.

