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KEY FEATURES OF THE PROJECT OF RAILWAY RECONSTRUCTION AND MODERNIZATION: SECTION ŠKRLJEVO-RIJEKA-ŠAPJANE

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Abstract

The Škrljevo-Rijeka railway section is part of the main international railway corridor M202 Zagreb GK-Rijeka, a part of the Mediterranean TEN-T corridor and the RH2 corridor. M203 Rijeka-Šapjane-State border line is also an integral part of the RH2 corridor. M202 is part of the EU Core Transport Network, while M203 is part of the Comprehensive Transport Network. They were both built and put into operation in 1873 and are in need for reconstruction and modernization. This paper presents the basic project features. The modernization includes the construction of the second track and the reconstruction of the existing track on the section Škrljevo-Rijeka-Opatija / Matulji in the length of about 23 km, and the reconstruction of the existing track from Opatija / Matulj to Jurdani in the length of 6.5 km. The existing stations and stops are being reconstructed to meet the requirements of the new organization of traffic and the upgrading of the second track, and new stops are planned for the establishment of urban and suburban traffic. Reconstruction and modernization of all other infrastructure subsystems, as well as the construction of a new Operations and Management Center for traffic management in the wider area of the country, are on their way. With presented solution, the railway line will meet the ports needs in Rijeka, Sušak and Bakar basins, and at the same time the needs of the city of Rijeka in terms of organization of passenger transportation in urban and suburban area.

Keywords: documentation preparation, design requirements, project solutions

1 Introduction

Global concept of TEN-T core network, according to data and documentation published by the European Commission [1 – 7], and in Croatian strategies and regulations [8, 9] is based on the fact that railway transport is of key importance for the efficiency of the European economy. Without good transport links, the European economy will not be able to grow and develop. As a means of boosting growth and competitiveness, a strong European transport network is being set up under the new EU infrastructure policy, covering 27 Member States. The starting point of the new European infrastructure policy assumes that freight traffic will increase by 80 % by 2050, and passenger traffic by more than 50 %. One of the basic goals and policies of the European Union is to encourage the use of intermodal transport, i.e., alternative solutions that put energy-efficient modalities of transport in the foreground, and at the same time are acceptable from the transport-technological and economic aspect. Therefore, the new modalities are also acceptable for environmental protection. The basic principle of this transport system is based on combining at least two types of transport in the transport chain where most of the road freight is transported by rail or inland waterways, while the representation of road transport is significantly reduced.

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The project of railway reconstruction and modernization on section Škrljevo-Rijeka-Šapjane, presented in this paper, is part of a broader project of establishment of a high-efficiency double-track railway for mixed traffic on the Croatian part of the Mediterranean Corridor, which connects the Iberian Peninsula with the Hungarian-Ukrainian border via the ports of Rijeka, Zagreb, and Budapest. The transport, technological and economic significance of this railway section stems from the fact that the Rijeka transport hub is connected to the interior of Croatia and part of the European area through it. Therefore, special emphasis is placed on the connection of this railway section to the TEN-T basic network of the Mediterranean Corridor, i.e., to the railway transport corridor RH2 on the territory of the Republic of Croatia. Also, the position of the Rijeka junction and connecting railways in relation to the spatial and urban plan of the city of Rijeka and its surroundings is extremely important for the development of urban and suburban passenger traffic. In addition, through the railway section Škrljevo-Rijeka-Jurdani, it is possible to connect all ports and other freight terminals to railway traffic.
The entire project is eligible for EU co-financing and the documentation creation was co-financed by the European Union Connecting Europe Facility.

2 Project requirements

Railway section Škrljevo-Rijeka-Jurdani consists of two sections: section Škrljevo-Rijeka which is an integral part of the main corridor line of importance for international traffic on corridor RH2, M202 Zagreb GK-Karlovac-Rijeka, and section Rijeka-Šapjane which is an integral part of the main corridor line of importance for international traffic on corridor RH2, M203 Rijeka-Šapjane-State Border (Figure 1). Along the entire length (27,494 km), the existing railway section is single-track, electrified by a single-phase AC system 25kV, 50Hz and equipped for the maximum allowed mass of D4 trains (22.5 t/o and 8 t/m).
The project is a complex and multidisciplinary in nature, as it overlaps with nine other projects in the corridor: Bus terminal Zapadna Žabica and extension of Riva Street (City of Rijeka); reconstruction of the freight part of the Rijeka railway station (HŽI) and construction of the container terminal (Rijeka Port Authority); Port of Rijeka (Port of Rijeka); State road D-403-from the Škurinje junction to the port of Rijeka (Croatian roads); business complex Interspar Krnjevo and RIO; underpasses 3. Maj and Rukavac and Matulji junction.
The railway section is very demanding since it passes mostly through the central urban area of Rijeka and Matulji, very complex relief and geological-geotechnical areas, through the zones of sanitary protection of springs, and large development area next to the railway. In the area, there are several buildings of importance for cultural and historical heritage, which further limits the choice of possible technical solutions and affects the investment.

Figure 1 Škrljevo-Rijeka-Jurdani (Šapjane) railway section

The required performance parameters for desired future rail line categorization (P4, P5 and F2) are as follows: available profile GB (P4, F2) and GA (P5); axle load 22.5 t/a (P4, F2) and 20 t/a (P5); line speed: 120-200 km/h (P4), 100-120 km/h (F2) and 80-120 km/h (P5); useful platform length for interoperable stations: 200-400 m (P4) and 50-200 m (P5); and train length 600-1050 (F2). However, the section Škrljevo-Rijeka-Jurdani passes through the Rijeka city area and topographically specific area, the maximum train speed will be limited to 70/80 km/h, with limited maximum train length. Therefore, reconstruction of the existing and construction of the second track of the open railway is designed for speeds up to 80 km/h with the associated infrastructure. The line reconstruction and modernization will enable the performance parameters given in Table 1. In addition, the renovation and modernization of all other infrastructure subsystems (construction, electricity, traffic management and signalling safety, and reconstruction of buildings in the function of railway traffic), as well as road infrastructure is included to meet traffic safety conditions.

Table 1 Design performance parameters

Traffic	Profile	Axle load (t/a)	Train speed (km/h)	Platform length (m)
P4 –P5	GC	22.5	70-80	160-400 m
F2	GC	22.5	75-80	420

3 Project solutions main features

The modernization of the existing railway includes the construction of the second track along the existing one and the reconstruction of the existing track on the section Škrljevo-Rijeka-Opatija/Matulji in the length of about 23 km, and the reconstruction of the existing track from Opatija/Matulji to Jurdani in the length of about 6.5 km. Existing stations and stops are being reconstructed to meet the requirements of traffic organization and upgrading of the second track, and new stops are planned due to the establishment of urban and suburban traffic [10 – 12]. The reconstruction and modernization of all other infrastructure subsystems, as well as the construction of a new Operational Management Center (OUC) for traffic management in the wider area of the country are also under way.

3.1 Track route and geometry

Horizontal and vertical track geometry is designed in accordance with the standard HRN EN 13803, and applicable technical regulations and European directives. In places where the existing horizontal arches must be reconstructed, the radii are selected so that the reconstructed route deviates as little as possible from the existing route, and that an intermediate straight of the prescribed length can be placed between adjacent curves. This project does not envisage the reconstruction or renovation of the railway line on the subsection Jurdani-Šapjane -DG and the existing route is retained. Only the reconstruction of the Šapjana station and the Permani stop is planned. During the design, the route of the existing railway track was largely retained with two deviations: in the part in front of the Škrljevo station and at the exit from the Škrljevo station by about 60 and 35 m.
From Škrljevo station to Rijeka station, the second track is being added on the right side. At the exit from Rijeka station, the axis of the line is shifted to the left by about 2.85 - 4.75 m, and the second track here is upgraded on the left to km 1+200. From there to the Opatija-Matulji station the route of the existing line is retained as the left track, and the new, second track is upgraded on the right side of the line at an axial distance of 4 m, thus avoiding upgrades of high embankments, and cuttings are widened. When designing the single-track line from Opatija/Matulji station to Jurdani station, the existing line route was fully respected

and retained, except at the exit from Opatija/Matulji station where the reconstructed station tracks should be connected to the existing line. Further along the open single-track line, the deviation of the designed axis from the existing one is minimal.
The minimum radius of the curve on the open track is 270 m and it is located where the line turns from Drage to the City of Rijeka at an angle of 100°.The vertical track geometry of the new second track and the reconstructed existing railway was mainly maintained on the entire railway section Škrljevo - Rijeka. The projected (as well as the existing) longitudinal slopes from Škrljevo station to Jurdani station are mostly around 25 mm/m. From Jurdani station to Šapjane station, the existing longitudinal slopes are milder, the largest of which is 16.8 mm/m. The distance between the track axes of the open double-track railway is 4 m. In the "A-V" connections, the track distance is 4.75 m. At the intersection with the future D403 road, the tracks are spaced at 5 m and at the underpass 3. Maj at 7.6 m.

3.2 Track superstructure and substructure

The superstructure of open tracks and main tracks in stations consists of new 60E1 type rails on prestressed reinforced concrete one-piece sleepers with elastic track fastening accessories and direct fastening without base plate. Concrete sleepers are positioned at an axial distance of 60 cm in ballast bed. The ballast is at least 30 cm thick below the sleeper at the side of the lower rail, 50 cm wide from the front of the sleeper, with a stone throw. To reduce vibrations and noise from the tracks, the installation of sleepers with elastic lining on the lower side of the sleeper (USP - under sleeper pads) is planned on the entire Škrljevo-Jurdani section. The track and switches will be welded into a continuous rail strip.
The plain of the double-track protective layer on the upgraded and renewed track is 11-11.20-11.50 m wide. The plane has a double-sided transverse slope of 5 %. The protective buffer layer is 30 cm thick. The plain of the single-track line on the renewed / modernized track is 6.70 - 6.85 m wide. The transverse drop is 5 % on one side in the width of 5.85-6.00 m, while the other part of the planum is 0.85 m wide (sidewalk) provided in the counter-slope.
Railway sections on which it is necessary to add a new track in cuts (there are several cuts over 20 m high by the surrounding construction), complex technical solutions and various structures must be applied to ensure soil stability and existing buildings. On railway sections where the existing track is laid on the embankment (there are existing embankments on the railway over 20 m high built at the time of railway construction, 150 years ago), the construction of the second track will be achieved by upgrading or widening the existing embankment. The widening of the embankment will be carried out by constructing stairs on the existing embankment, and by installing embankment material with the application of modern materials and methods of slope stabilization.
The project envisages the reconstruction of the existing and the construction of a new drainage system. The drainage of the railway area outside the water protection zones and hydrogeologically sensitive areas is provided by a system of parallel ditches (channels) with direct discharge into the recipient without special wastewater treatment. A closed drainage system is planned at the places where the railway passes through the zones of the sanitary protection of springs. Water from the internal drainage system will be treated in oil and grease separators with integrated filters and, if necessary, in infiltration ditches before being discharged into the recipient. The design solutions ensure that wastewater from bridges is not discharged directly into the watercourse but is collected and redirected to a system of parallel ditches of external drainage. Wastewater from bridges in closed protection zone before discharge into the recipient will be treated in oil and grease separators. Other facilities in the area (roads and parking lots) will have solved local drainage systems in accordance with the special conditions.

3.3 Stations and stops

The stations are being reconstructed to adapt the track plan to the second track, and to achieve greater useful track lengths, to improve the functionality of the station for the purpose of meeting or overtaking trains. The existing reception buildings are being reconstructed due to the need to arrange the space for the accommodation of ESSU, ITK and TK devices within the station buildings.

Škrljevo station will remain an intermediate station on the line M202 Zagreb GK–Rijeka, a separate station for the line M602 Škrljevo–Bakar and becomes the terminal station of urban-suburban traffic of the city of Rijeka. Due to the new track plan, the reconstruction of the existing garage group of tracks is necessary. The total number of tracks in the group will decrease compared to the existing condition, but the useful length of individual tracks will increase. The garage group itself is very important for local work at the station and servicing the Kukuljanovo industrial zone.

The function of the Sušak/Pećine station will not change. This will be an intermediate station on the line M202 Zagreb GK-Rijeka, and a separate station for the line M603 Sušak/Pećine-Rijeka Brajdica. It will be used for urban-suburban and local passenger transport.

Rijeka station will remain the distribution and shunting station of the M202 and M203 line. The station will be open for the passengers in domestic and international traffic as well as all types of wagon shipments. This project included the reconstruction of the track in the passenger part of the station. It is planned accommodate long-distance trains, i.e., passenger trains longer than 160 m, at the station.

With the addition of the second track, Opatija/Matulji station will become an intermediate station for passengers in local and international transport, as well as a station for switching from double to single-track. In urban-suburban traffic, the station becomes the terminal. The reconstruction includes all existing station tracks. After the reconstruction, it will have 4 main tracks and two garages. One for garaging the city suburban train set and the other for garaging motor rail vehicles.

Jurdani station will be located on a single-track section of the modernized line M203. It will be open only for passengers and have 4 tracks.

Šapjane station will remain the border station. The project envisages a complete reconstruction of the station, considering space constraints related to the width of the station plateau on the right, as well as the slope of the railway line at the entrance, which limits the possibility of extending the station towards Jurdani. After the reconstruction, four receiving and dispatching tracks are planned at the station.

Reconstruction of existing or construction of new stops in the function of urban and suburban passenger traffic is planned on the projected section of the railway. New stops are planned: Draga, Vežica, Zagrad, Kantrida, Zamet, Martinkovac, and reconstruction of the existing ones: Krnjevo, Rukavac, Jušići and Permani. Side platforms 0.55 m high above the TOR, 160 m long, are planned at the stops.

For the connection of platforms at stations and stops, the construction of new underpasses with a clarence width of 4.8 m is planned. In the stations where it is not planned to stop long-distance trains, i.e., passenger trains longer than 160 m, two side platforms 160 m long, 3.50 m wide and 0.55 m high from the TOR at 1.65 m from the line axis are planned. Canopies 24-80 m long are planned on the platforms.

3.4 Structures and tunnels

There is a significant number of structures, and some of them are the subject of interest of the conservation department. Reconstruction of all underpasses, overpasses, viaducts, and bridges is planned because, regardless of the condition of the structure, the geometry does not meet the requirements for the passage of the second track.
On the section Rijeka - Jurdani, which is subject to reconstruction and renovation, there are 5 overpasses, 8 underpasses and 7 overpasses. The largest underpass opening is 32 m long Matulji underpass over the state road to the Učka tunnel.
On the section Škrljevo - Rijeka there are a total of 2 tunnels and one gallery. The Baudine tunnel is completely abandoned by the deviation, and a new tunnel is envisaged, while the Kalvarija tunnel and Zagrad gallery are retained as they are reconstructed according to the profile. The existing railway tunnel Kalvarija, 452 m long, was built in 1873 for a two-track railway. Zagrad Gallery has a total length of 206.42 m. The project envisages the construction of two more galleries: Sv. Ana, approximately 350 m long, and the Ciottina Gallery (a continuation of the Zagrad Gallery), approximately 90 m long.
On the Rijeka-Šapjana section, there is one railway tunnel, Rukavac, 312.40 m long. The tunnel is located between Jurdani and Opatija/Matulji station. The tunnel, elliptical in shape, was built in 1873. The tunnel will be reprofiled and equipped for the required cross-section of the single-track line.

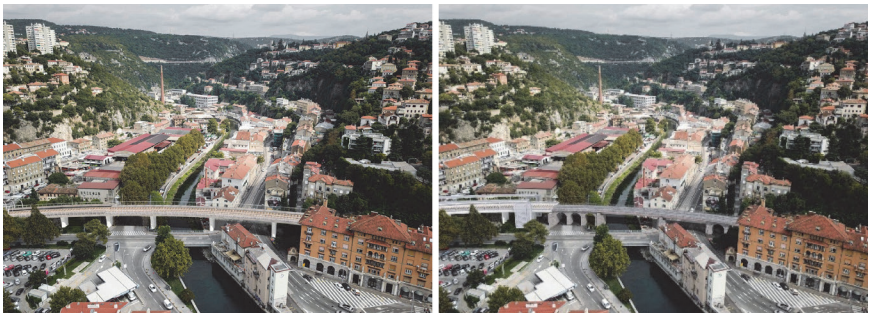

Figure 2 Rječina-Školjić viaduct solution option (new facility – left, reconstruction and upgrade - right)

4 Conclusions

Although the section of the railway Škrljevo-Rijeka-Jurdani is relatively modern, it is not able to meet all the required functions and goals. The very fact that it is a single-track line limits its capacity and transport capacity, making it a bottleneck in the transport system of European and national corridors in the area. The European Union has recognized the need to eliminate the existing so-called bottleneck around the Rijeka hub, which would enable the further development of the existing capacities of the Port of Rijeka and the creation of efficient urban and suburban railway transport. That is why in 2015, it allocated 8.5 million euros from the Instrument for Connecting Europe for the project for the preparation of project documentation, which is 85 percent of the eligible project costs of 10 million euros. The remaining part of the maximum value of the project in the amount of 1.5 million euros is co-financed by the Republic of Croatia.
The main goal of the study and technical documentation for the construction and reconstruction of this railway section was to define, in a modern and professional way, all solutions related to the preparation of construction, reconstruction, and modernization of the railway section and meet the necessary conditions for land acquisition and construction permits.

The goal of created main designs was to achieve conditions for starting the construction of sections in the manner required by international financial institutions (financial and technical profitability, proven through a feasibility study and feasibility study, conceptual and main design) considering all provisions and measures of Environmental impact studies. Therefore, the goal of the entire project was to ensure the upgrade this railway needs to accommodate a larger amount of passenger and freight traffic. As this paper shows, needed upgrade primarily refers to the construction of the second track with the reconstruction of existing one, and the construction and modernization of stations and stops for passenger traffic, and of all ancillary facilities on the line. Presented railway infrastructure upgrade will increase the quantity and quality of all modes of transport in this area.

References

[1] White Paper 2011-2020 - Plan for the Single European Transport Area

[2] Trans-European Transport Network, TNT-T Core Network Corridors, European Commission 2014.,

[3] New Policy EU Transport Infrastructure (Mediterranean Corridor), EC Brussels, 2014.,

[4] Europe 2020 - Strategic Framework of the European Union,

[5] Rail Freight Corridor 6 - Implementation Plan - EU 09.04.2013- 17.04.2013.,

[6] Rotterdam Ministerial Declaration on the Implementation of the Trans-European Transport Networks (TEN-T) adopted on 20 June 2016.,

[7] Ministerial Declaration of Rotterdam on Railway Freight Corridors for the Promotion of International Rail Freight Transport of 21 June 2016.,

[8] Transport Development Strategy of the Republic of Croatia (2014-2030), October 2014.

[9] Act on Safety and Interoperability of the Railway System, Official Journal 63/20

[10] Feasibility study of the project Construction of the second track, reconstruction and modernization of the railway section Škrljevo-Rijeka-Jurdani, Institut IGH, dd Zagreb, November 2017.

[11] Environmental impact study Construction of the second track, reconstruction and modernization of the railway section Škrljevo-Rijeka-Jurdani, IGH Institute, dd Zagreb, Granova, doo Zagreb, November 2017.

[12] Preliminary design for the construction of the second track, reconstruction and modernization of the railway section Škrljevo-Rijeka-Jurdani-Šapjane, Institut IGH, dd Zagreb, Granova doo Zagreb, October 2019.