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CONCEPT OF RECONSTRUCTION AND MODERNIZATION OF RAILWAY TRACKS OF ROUTE 9A – DOBOJ-TUZLA-BRČKO SECTION

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Abstract

War developments in the mid-1990s, economic crisis and the lack of funds to reconstruct railway infrastructure and the fleet have led to the situation that railway traffic in Bosnia and Hercegovina (BiH) goes at low speeds with low efficiency and limited scope of railway services. Significant activities have been taken within SEETO (South East Europe Transport Observatory) aimed at restoration and development of the railway network in BiH. According to SEETO Comprehensive Network Development Plan 2014 a railway Route 9A: Banja Luka–Doboj–Tuzla–Brčko was defined, 224 km in total length. The paper presents the concept of reconstruction and modernization of the Route 9A railway tracks at (Srpska Kostajnica) Doboj –Tuzla – Brčko section. This section forms part of 47 % of total railway track length at Route 9A and is of exceptional significance in international traffic and exchange of passengers and goods between BiH and the Republic of Croatia and the Republic of Serbia. Brčko railway station makes the railway connection with the Port of Brčko, which is the most important port at the Sava River in BiH. Also, this railway track section represents a potential alternative direction to railway tracks of Corridor X and Corridor Vc.

Key words: reconstruction, modernization, railway track, route, section

1 Introduction

Intensive privatisation and recovery of heavy industry in Bosnia and Herzegovina (BiH) have opened new possibilities for development of railway sector since the efficient railway transport contributes directly to overall competitiveness of the BiH economy. The existing railway infrastructure is not capable of responding to growing demand in the medium-term period and this is why considerable efforts are made for the railway structure in BiH to be raised on a higher level. The main railway routesin the territory of Bosnia and Herzegovina are:
- North-South route which belongs to the Pan-European corridor Vc and it connects the countries of the Central Europe with the Adriatic Sea.
- East-West route, parallel to Pan-European corridor X, over which the connection is established with Southeast Europe and the countries of the Middle East (Figure 1).

Modernization of railway traffic in BiH is focused on railway lines along the basic SEETO (South East Europe Transport Observatory) railway network (Figure 2).
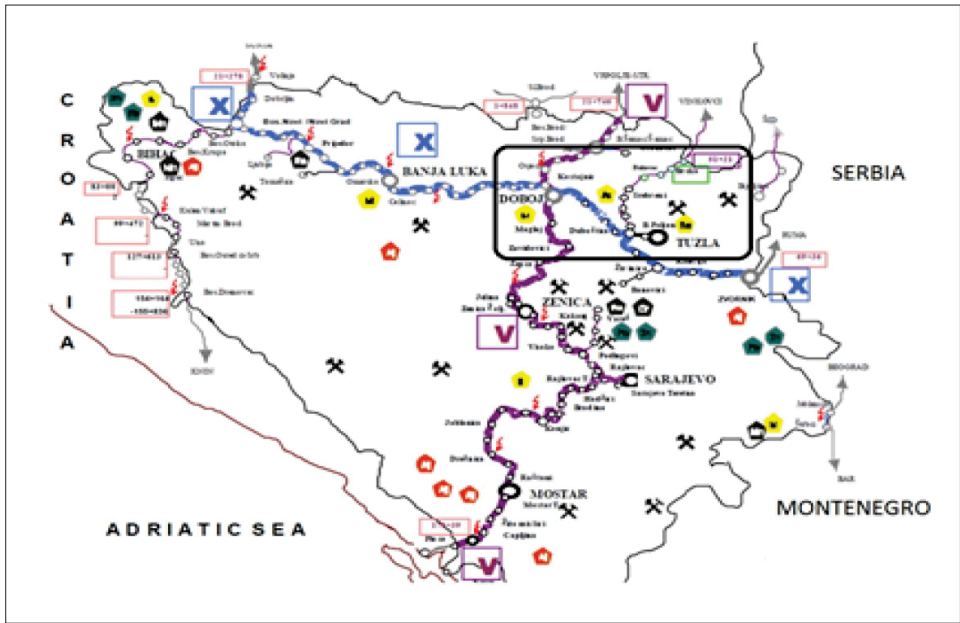
Figure 1   Railway lines in BiH and location of industrial activities

Figure 2   SEETO Comprehensive network

According to "SEETO Comprehensive Network Development Plan 2014", 224 km long railway route "Route 9A: Banja Luka–Doboj–Tuzla–Brčko" has been defined. Railway sections at (Srpska Kostajnica) Doboj – Tuzla – Brčko route are a part of Route 9 and make about 47 % of its total length. The railway is connected with the Port of Brčko at the Brčko station. The 2003 REBIS study suggests the importance of the Port of Brčko for the development of transport system in the region, and consequently the importance of the development of logistics transport chain the basic linkof which is Tuzla-Brčko railroad. As this is an important industrial region in BiH, the significance of this railway route is multiple, primarily in cargo traffic, but a considerable increase of passenger traffic can be expected following the modernization of the railroad and better transport services provided.

The implementation of the project of reconstruction and modernization of railway sections at (Srpska Kostajnica) Doboj-Tuzla-Brčko route will result in:
• Increased scope of cargo traffic considering there is rather a developed industrial zone through which a considered railway route passes;
• Influence on the development of the Port of Brčko which has capacities and works on the expansion of its terminal, but also the development of the Port of Ploče, which is regionally rather an important port for Bosnia and Herzegovina;
• Improved quality of services, security and reliability of passenger traffic on the Srpska Kostajnica-Tuzla route, but also the revival of passenger traffic on Bosanska Poljana (Tuzla)–Brčko route which is not functional from late 2010, and
• Considerable economic growth of the region along the infrastructural corridor, where industrial production exists.

2 Generating variant solutions

2.1 Characteristics of variant solutions

According to the design specifications technological parameters have been determined based on which the concept of reconstruction and modernization was created of railway sections on (Srpska Kostajnica) Doboj-Tuzla-Brčko route. Variant solutions are formed based on the following requirements:
• Design speed from 80 to 120 km/h.
• Modernpower supply, signalling-safety and telecommunication facilities and units.
• Effective length of reception and departure tracks from 650 to 750 m.
• The number of tracks is determined according to technological tasks of service points.
• Adequate capacities for personnel with modern working equipment.
• Stations and stops are equipped to offer adequate transport services in passenger traffic.
• Stations are equipped to offer adequate transport services in cargo traffic.
• To maintain all the existing connections with industry via industrial tracks.
• To solve the problem of intersection ofrailroad and road traffic transport routes.
• Stations are equipped with station platforms with underpasses and footbridges.
• Construction of station platforms and underpasses to be done in stages.
• As for the scope of work, certain stations should be provided with cargo work facilities.

In accordance with technological requirements variant solutions have been defined within DO OPTIMUM and DO MAXIMUM concept. Optimum concept (DO OPTIMUM) meant minimum speed at tracks of 80 km/h, which would increase to 120 km/h at the sections which spatially and topographically would allow for it. Within this concept two solutions have been suggested, DO OPTIMUM 1 and DO OPTIMUM 2. Maximum concept (DO MAXIMUM) implied variant for the speed of 120 km/h at all railroad sections which is limited to the existing speed only at the exit from Doboj and Tuzla stations respectively because it is not possible to extend the radius of horizontal curves which exist in the area of the said stations. The reason is in spatial limitation. As for the adopted concept of reconstruction and modernization of railway tracks, optimization of level crossings was made. Taking into account the spatial limitations, the purpose of areas, as well as the current regulations related to the planning of road crossings in BiH [10], the following variant solutions have been formed:
1) Variant solution DO OPTIMUM 1a – in addition to the proposed concept of reconstruction of railway sections DO OPTIMUM 1, optimization is to be done of level crossings without delevelling of crossings;
2) Variant solution DO OPTIMUM 1b – in addition to the proposed concept of reconstruction of railway sections DO OPTIMUM 1, optimization is to be done of level crossings with delevelling of crossings at the places where spaceconstraints allow for it.

3) Variant solution DO OPTIMUM 2a – in addition to the proposed concept of reconstruction of railway sections DO OPTIMUM 2, optimization is to be done of level crossings, without delevelling of crossings.
4) Variant solution DO OPTIMUM 2b – in addition to the proposed concept of reconstruction of railway sections DO OPTIMUM 2, optimization is to be done of level crossings with de-levelling of crossings at the places where spaceconstraints allow for it, and
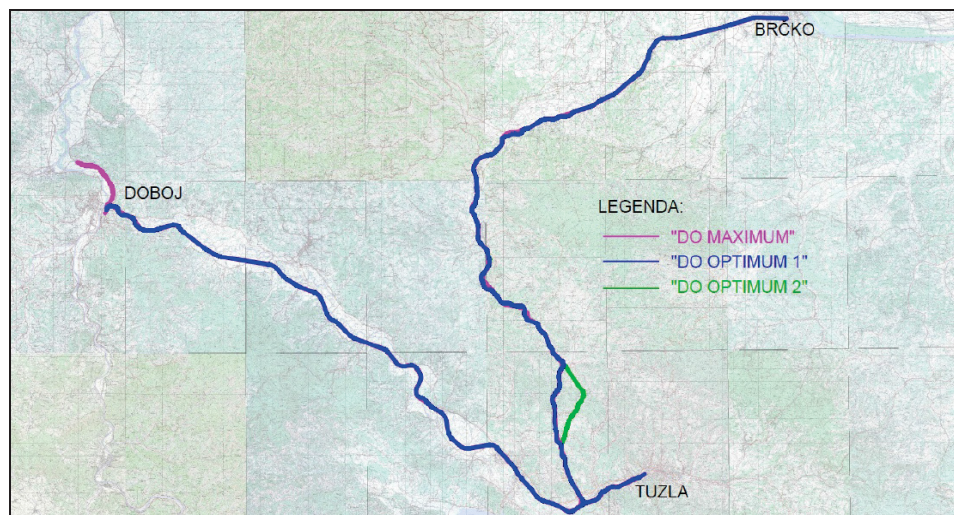5) Variant solution DO MAXIMUM – all crossings with road traffic transport routes are dele-velled, [1].

Figure 3   Variant solutions of railway routeSrpskaKostajnica-Doboj-Tuzla-Brčko

2.2 Selection of variant solution

Evaluation of the proposed variant solutions has been made by multi-criteriadecision making VIKOR [3] method according to 18 criteria with set weights (ω) as follows: investment value (ω=0.167), maintenance costs (ω=0.214), train-handling capacity of a line (ω=0.115), travelling time (ω=0.043), energy consumption (ω=0.043), safety (ω=0.860), incorporation into the-routes of development of the network and other traffic systems (ω=0.420), preservation of space wholes (ω=0.420), space occupation (ω=0.210), consequences of division (ω=0.350), noise (ω=0.045), vibrations (ω=0.023), water pollution (ω=0.029), soil pollution (ω=0.030), area occupation (ω=0.023), flora and fauna (ω=0.019), microclimate (ω=0.016) andvisual pollution (ω=0.012). After the evaluation has been made the following ranking list of variant solutions was obtained:

Set of alternatives	Advantage
A 2.DO OPTIMUM 1b	18.0 %
A 1.DO OPTIMUM 1a	0.2 %
A 4.DO OPTIMUM 2b	18.3 %
A 3.DO OPTIMUM 2a	26.2 %
A 5.DO MAX	0.0 %

The first place within the set of compromise solutions was taken by the variant solution DO OPTIMUM 1b with 18.0 % advantagein comparison with the variant solution DO OPTIMUM 1a. Variant solution DO OPTIMUM 1a has slight advantage in comparison with variant solution DO OPTIMUM 2 b (0.2 %). The two first-ranked solutions have been considered further with higher degree of thoroughness.
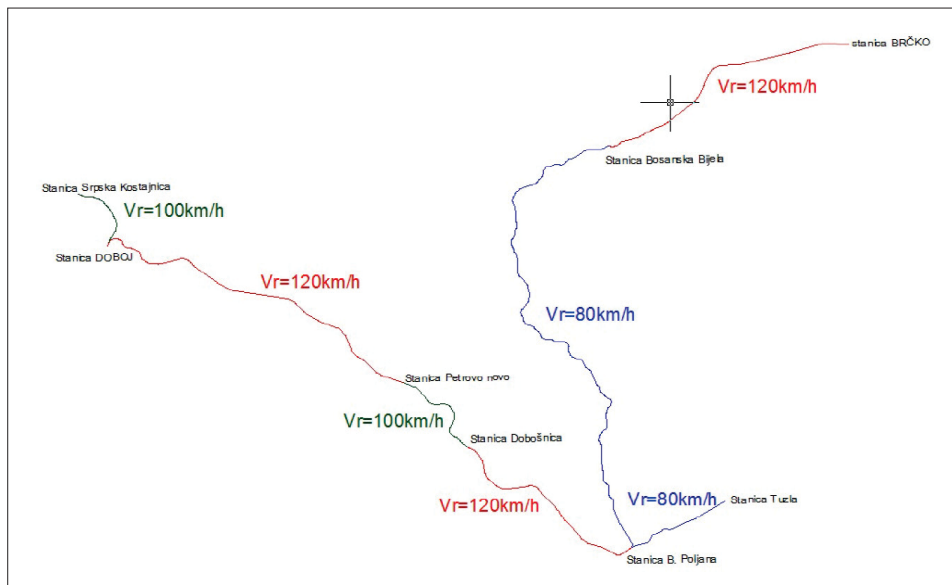
Figure 4   Selected variant solution of railway route Srpska Kostajnica – Doboj-Tuzla – Brčko DO OPTIMUM 1

3   Optimum variant solution DO OPTIMUM 1

Variant solution of railway track route DO OPTIMUM 1 has geometrical elements of a route determined in relation to horizontal axis g-force b=0.65m/s^2. Transition curves are shaped as rectified cubic parabolas with linear transitional profile. Maximum designed gradient is 15 ‰. In all stations the passing tracks are designed with maximum effective length of 650.0 m. Designed platforms in stations are minimum 110.0 m long, while at the stops the length of platform is up to 150.0 m. The designed height of platform is 0.55 m above the top of rail. Minimum width of trough platforms is 6.20 m, and of end platformsit is 3.0 m. The platforms are connected byunderpasses, [7]. Type 60E1 rails, 900A quality, are predicted to be installed, welded into a long railway track. Rail fastenings are elastic, while the sleepers are predicted to be made of pre-stressed concrete 2.60 m long, [6]. Variant solution includes complete demolition and removal of the existing bridge structures and designing and building of new ones. It is predicted that new structures would be made of reinforced or pre-stressed rein- forced concrete, in accordance with the spans, [9]. According to variant DO OPTIMUM 1, it is predicted to build seven tunnels 1845.0 m in total length. They are all designed as single track tunnels with clearance in which safety evacuation zone is included, 0.80 m wide and 2.20 m high inside the curve. Based on hydraulic calculation the dimensions are determined of elements of facilities so that they could receive and conduct high water flows of the given return period in order to protect railway sections. It is provided to regulate water-course bed in the zone of the bridges. At the railway section which is located in the territory of the Bosnia river basin there would be regulation of the Spreča river and the confluence of the Sikulačka and the Spreča rivers, approximately 1900 m. The design provides for the works at the exi- sting architectural facilities, the construction of new facilities and equipping of ground floor surfaces in accordance with the valid regulations and technological requirements. Within the design of power supply facilities and units, the solutions have been considered and proposed of electric traction system, remote traction operation centre, technology of supplying in train stations, electro-technical devices in train stations, the centre of remote diagnostics system and control of railway equipment, as well as moving of the existing electric ground level installations which intersect with the railway track. Signalling and safety facilities and units require comprehensive change until full compatibility with contemporary technical conditions of signalization is achieved. As a part of modernization of railway track it is provided to install completely new telecommunication equipment and devices.

4 Financial and economical analysis

Based on the proposed conceptual designs the estimate was made of the investment value for the entire construction and electro-technical infrastructure, as well as an estimate of investment value for expropriation of facilities and land along the corridor of railway track route. The total investment value (VAT excluded) for variant solution DO OPTIMUM 2a amounts to 418,992,256.00 EUR, and for variant solution DO OPTIMUM 1b it amounts to 401,226,326.00. In case of variant solution DO OPTIMUM 1a, the parameters of financial analysis have shown that the subject track is not financially cost effective (economic internal rate of return is 8.80 › 5.0, and the benefit-cost ratio is 2.59. For variant DO OPTIMUM 1b, the parameters of economic analysis are slightly more favourable (economic rate of return is 8.38 › 5.0, benefit-cost ratio is 2.31). Such results of financial analysis suggest that a grant is necessary so that this project, which is significant for the development of economy in the country, would be financed at all.

5 Conclusion

Through the comprehensive analysis of traffic, space, the existing infrastructure within the corridor and environmental protection, the possible variant solutions have been generated for the reconstruction and modernization of the railway track (Srpska Kostajnica) Doboj–Tuzla–Brčko. Multicriteria analysis was used to determine a rank of variant solutions according to the adopted pattern of aims, criteria and indicators. The first two variant solutions at the rank list have been considered in the further procedure of making documentation. Contrary to the results shown which suggest that the project is not feasible from financial aspect and is not self-sustainable if we observe the money flow, from the aspect of economic evaluation we can conclude that the project is economically beneficial for the society of Bosnia and Herzegovina. From the aspect of traffic development and integration into other traffic network, it is important to mention that the variant solution DO OPTIMUM 1b is considerably more favourable considering that the key track crossings have been delevelled.

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