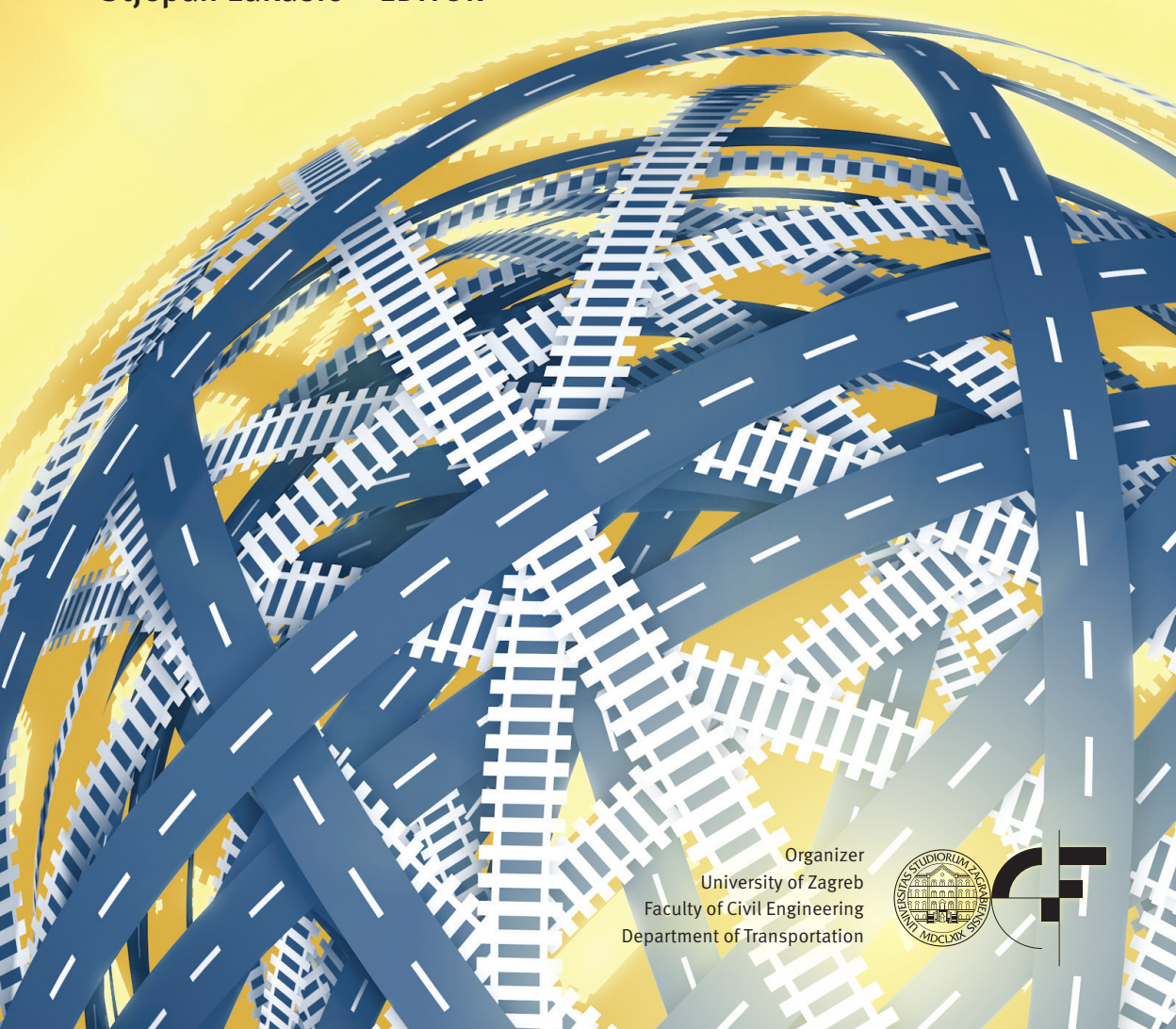
CETRA 2016

4th International Conference on Road and Rail Infrastructure
23-25 May 2016, Šibenik, Croatia

Road and Rail Infrastructure IV

Stjepan Lakušić – EDITOR



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THE EFFECTS OF GENERAL OVERHAUL RAILROAD IN FB&H

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Abstract

After completion of the first phase of the project of general overhaul main repair of the railway line from the state border (Čapljina) to Bradina, in the Federation B&H, a general overhaul from Bradina to Sarajevo, in total length of 36 km, currently is in progress. Implementation of Phase II of this project will be completed general overhaul of whole so-called south line from Čapljina to Sarajevo. General overhaul of railroad includes replacement of superstructure elements, while a just few works consider improving the substructure, structures (bridges, tunnels) and technical elements (radius of curves and etc.). This paper will give an overview of line condition before and after the general overhaul implemented, and effects of this way of implementation of the general overhaul in terms of increasing speed and traffic safety.

Keywords: railroad, overhaul, increasing speed

1 Introduction

The railway line from the state border (Čapljina) to Sarajevo, known as the ''South railway'' is one of the most important railway lines in Bosnia and Herzegovina, and it is part of Corridor Vc. Its importance is recognized by Austro-Hungarian monarchy, which, eager to establish communication to the sea, decided to build the railway.
The first section of this line from Metković to Mostar was opened at 14.6.1885, and at 22.08.1888. section Mostar – Ostrožac was opened. The first train arrived in Konjic at 10.11.1889. Part of the railway from Konjic to Sarajevo was opened at 1.8.1891. and in that way connection with Adriatic sea was made.
The biggest problem on this section was a watershed Ivan sedlo, a boundary between Black and Adriatic sea, which is overcome by applying steep longitudinal slope (up to 60 ‰ on the section between Konjic and Bradina, and up to 35 ‰ between Pazarić and Bradina). The steep slope problem on these sections was partially solved in 1931. when long tunnel Bradina was build (322.3 m). This narrow gauge is modernized and become normal gauge in 1968., and a year later was electrified.
After the war (1992-1995), the damage was repaid, but from 2004. there have not been any serious reconstruction works. That year, general overhaul on the most difficult section of the railway (Bradina – Konjic) began.
Based on the strategy of the reconstruction and development of the railway sector in Bosnia and Herzegovina (Regional project ''Reconstruction of railways in B&H II''), during 2014, reconstruction of south part of the corridor Vc (100 km of railway – state border with Croatia – Čaplji-na – Mostar – Raška Gora – Čelebići (Konjic)) was completed. Whereas previously was done reconstruction of the Konjic – Bradina railway, the next task was to ensure the project and funds for reconstruction of remaining part of the railway from Bradina to Sarajevo, in total length of 42 km. Necessary funds and design for reconstruction of the final section from Bradina to Miljacka junction are provided, so realization of this project began in 2015. and is still in progress.

2 Parameters and conditions of the railway Sarajevo-Čapljina before general overhaul

The railway is single-track line and mostly build in extremely adverse terrain conditions. Therefor, in order to avoid high costs of building, it was necessary to apply minimum geometric elements. The total length of this section is 171.76 km and the entire length of the railway is electrified and equipped with signal-safety devices. The total length of straight line is 80.54 km (about 47%), while 91.21 km are curves (about 53%). The minimum applied curve radius is 250 m, while maximum is 10,000 m.
Figures 1 and 2 shows the presence of a certain curve radius, as well as a percentage share of certain curve radius in total length of curves. The railway was originally designed for speed of 70, 80 and 100 km/h. However, these geometric parameters are, according to the regulations, for speed below 100 km/h. For that reason, there is speed limit of 70 km/h for most of the route, while only small percentage of railway allows speeds higher than 90 km/h.

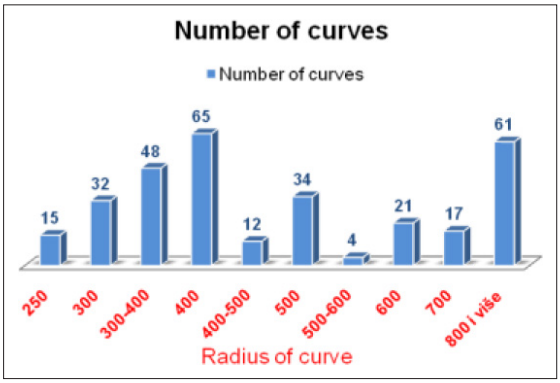

Figure 1 Number of curves

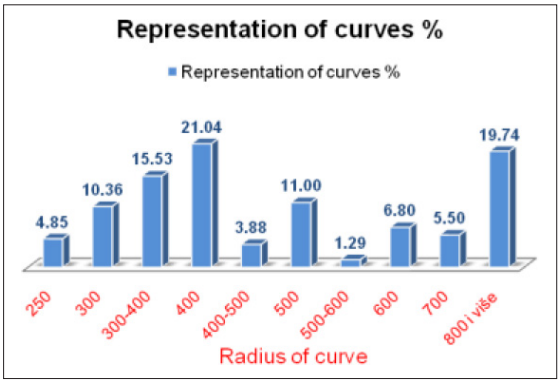

Figure 2 The presence of curves

There are a lot of objects on this railway, 99 tunnels (22% of the total railway length) and 51 bridges/viaducts (2% of the total railway length). Tables 1 and 2 shows the number of the objects per sections.

Table 1 The presence of tunnels per sections

Section	Length [m]	Tunnels		
		No	Length [m]	Length ratio [%]
Junct. Miljacka – Bradina	34,079.00	11	7,759.00	23.00%
Bradina – Konjic	25,245.00	45	11,753.00	47.00%
Konjic-Raška Gora	50,211.00	35	14,117.00	28.00%
Raška-Gora-Čapljina	56,255.00	8	3,037.00	5.00%

Table 2 The presence of bridges per sections

Section	Length [m]	Bridges		
		No	Length [m]	Length ratio [%]
Junct. Miljacka – Bradina	34,079.00	11	930.00	2.73%
Bradina – Konjic	25,245.00	16	1,165.00	4.61%
Konjic-Raška Gora	50,211.00	16	1,601.00	3.19%
Raška-Gora-Čapljina	56,255.00	8	330.00	0.59%

In the period after the war to the beginning of the general overhaul (1995-2005) ther were not large traffic accidents. Before reconstruction of the railway superstructure, railway age was about 40 years. Existing track featurs allows driving speed up to 100 km/h and they not satisfy some of the basic criterias (Table 3) of the European Agreement on Main International Combined Transport Lines and Related Installations (AGTC).

Table 3 The basic parameters of the railway Sarajevo-Čapljina

	Parameters	Sarajevo-Čapljina	AGTC		
			Existing lines		New lines
1.	Number of tracks	1	–	–	2
2.	Loading gauge	UIC B/C1		UIC B	UIC C1
3.	Minimum distance between tracks [m]	–		4.0	4.2
4.	Nominal min. speed [km/h]	50	100	120	120
5.	Allowed mass per axle [t] wagons ≤ 100 km/h ≤ 120 km/h	22.5t	20 20	22.5 20	22.5
6.	min. usable length of secondary track [m]	approx. 500	600	750	750

Based on these data (Table 3) it can be concluded that the largest deviations of the existing railway line parameters, in relation to AGTC, are in terms of the nominal speed.
Figures 1 and 2 shows that there are 309 curves on this railway section, with 210 curves (68%) of radius smaller than 600 m, which is 76.27% (69,859.44 m) of the total length of curves (i.e. 40% of the total length of the section). So, to accomplish the regulations in terms of driving speed, it is necessary to change alignment parameters on the large part of the route. Before general overhaul of the first section started, the busiest line in terms of passengers traffic was Sarajevo – Konjic section, while in terms of freight traffic it was section Mostar (Bačevići) – Čapljina (state border) (Table 4).

Table 4 Passengers and freight traffic on the Sarajevo – Ploče railway

Section	Passengers traffic		Freight traffic	
	Passengers [1000/year]	Pair of trains	Freight [1000 t/year]	Pair of trains
Junct. Miljacka – Bradina	150	17	200	8
Bradina – Konjic	120	17	200	8
Konjic-Raška Gora	90	17	200	8
Raška-Gora-Čapljina	30	12	200/450	18

Although, traffic study that preceded the main design, predicted increase of the passengers and freight traffic, in last ten years there has been further reduction in passengers traffic volume, while freight traffic volume remain the same.

3 The main design of the general overhaul

Since the ''southern railway'' is one of the most important transport lines on the Pan-European corridor Vc, in the process of developing of the strategy for reconstruction and development railway sector in Bosna and Herzegovina, priority was the reconstruction of this railway line. The main objective of the reconstruction design is to increase the safety of traffic, increasing the speed and reducing the cost of operation and maintenance.
Traffic studies and main designs were prepared with EU grant funds, and EBRD London and EIB Luxembourg credits were used for realization of this project, which took place in the following stages (Table 5). These costs (Table 5) are related to the construction costs, while the costs of renewal of signaling on the Konjic – Čapljina (ŽFBH) section amounted to 11.742.602,72 euros.

Table 5 Project realisation overview

	Section	Year	Contractor	Investment [€]
1.	Junction Miljacka – Bradina	2015.	GCF-Generale Costruzioni Ferroviarie / Hering d. d. Š.Brijeg	25,418,039.00
2.	Bradina – Konjic	2005. – 2006.	POOR Wien / Remont pruga d.o.o	16,000,000.00
3.	Konjic-Raška Gora (ŽFBH)	2009. – 2011.	Swietelsky / Alpine, Austrija	26,099,226.25
4.	Raška-Gora-Čapljina (ŽFBH)	2009. – 2011.	Swietelsky / Alpine, Austrija	25,008,123.08

According to the terms of reference, replacement of the superstructure elements (rails, sleepers and ballast) and switches and establishment of the continuous welded rail are most important works, while there are just a few planned works on the substructure reconstruction (only drainage works and rail body stabilization). More complex works are processed in a special individual projects. The ratio of investment between superstructure and substructure is approximately 70% -30%.

4 General overhaul effects

The effects of general overhaul are manifested through increased traffic safety, reduced costs of superstructure maintenance, increasing speed where terrain conditions and track geometry parameters allows, improving drainage and reduced maintenance costs of rolling stock. The largest effects of conducted overhaul "of the southern railway" is reflected in the increase of traffic safety and the lowest in terms of increasing the driving speed. Of course, the main reason for this is that geometric elements have not changed (repaired) so the speed remained almost the same (Table 6).
Thus, most part of sections with horizontal curve radius of 300 m still has speed limit of 75 km/h. The exceptions are few sections of the railway Raška Gora – Čapljina where speed is a

little bit higher (up to 90 km/h) and section Bradina – Konjic, with minimum curve radius of 250 m and a maximum longitudinal slope of 23 ‰, where possible speed is of up to 70 km/h. Comparing speed on the basis of the timetable before and after the track overhaul, it can be noted that they remain the same, up to 70 km/h for passengers and 50 km/h for freight trains, except on section Bradina-Konjic where speed of 50 km/h is also for passenger trains.

5 Conclusion

In order to achieve the competitiveness of rail with other modes of transport and especially in terms of passenger traffic, it is necessary to increase the capacity and driving speed. The realization of the railway reconstruction project, which is in progress and applies only to the reconstruction of the track without geometric elements correction and substructure reconstruction, these objectives cannot be achieved.
Therefore, this project can and should be seen as the first stage in the process of revitalizing the railways in B&H, while in the second phase should be based on finding solutions to the corrections of the route in order to increase speed and to meet the basic conditions of the signed agreements (AGTC).
Special attention should be paid to the substructure structures (tunnels and bridges) whose construction is quite dilapidated and require prior extensive testing and reconstructions. Since there is a highly challenging terrain conditions, it would require the construction of a completely new sections independent of the existing route that can be considered and second track. This approach to the reconstruction of the railway is a major advantage because it increases line capacity and allows the smooth traffic flow on the existing railway line, which was one of the main problems in the implementation of the overhaul project.
Of course, the key factor are costs, because it is an extremely difficult terrain and the improvement of the route is only possible by using large (long) structures (tunnels and bridges) which requires major investments. For this purpose it is necessary to make a detailed analysis and determine the highest priority sections where we can expect a return on investment. In addition, what is crucial for the revitalization of the railway is a change of transport policy so that the railway is the "backbone" of transport system.

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