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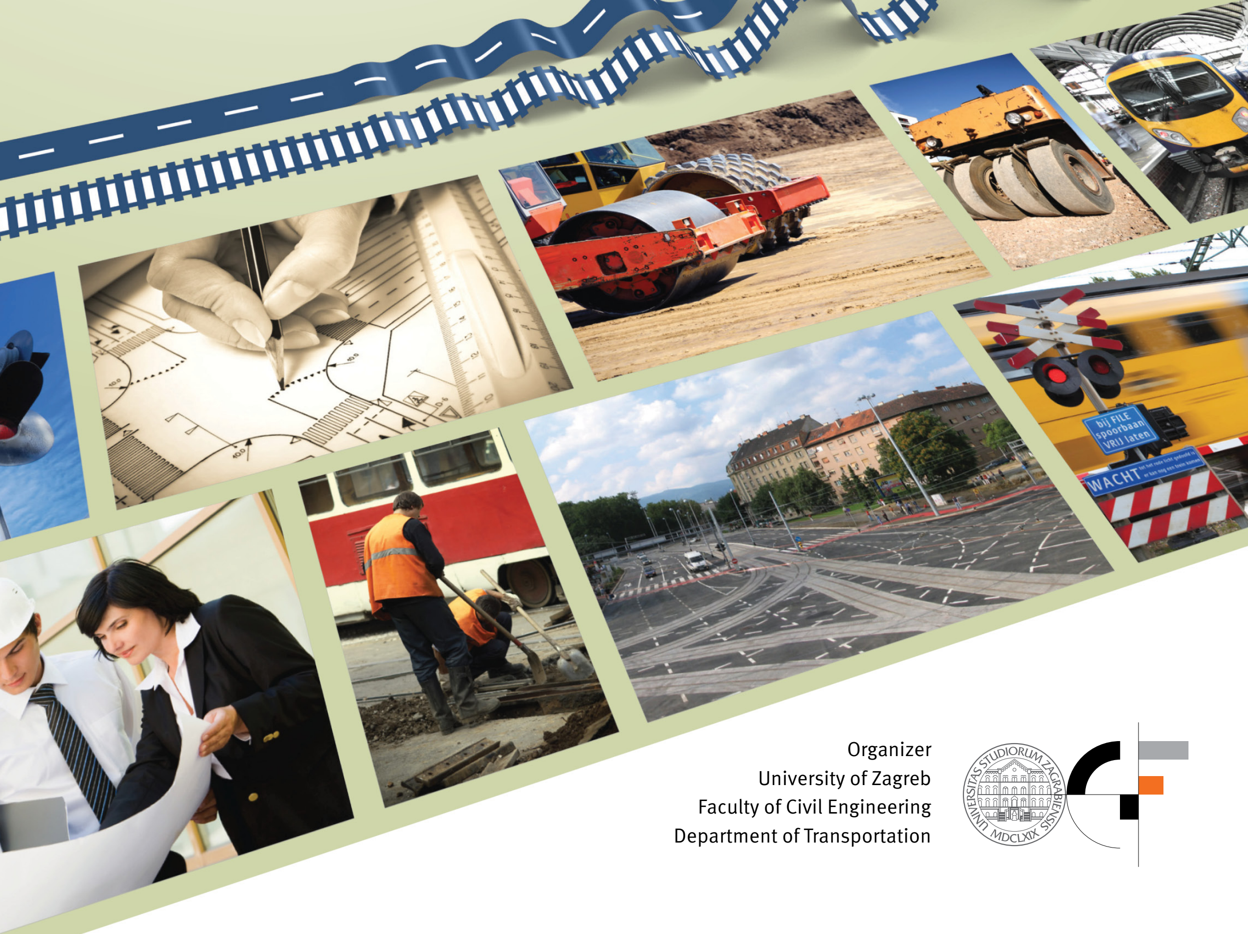
Road and Rail Infrastructure II

Stjepan Lakušić – EDITOR



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MODERNIZATION OF RAIL ROUTE 10 – KOSOVO RAILWAYS

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Abstract

The paper describes main objectives and conclusions drawn from the creation of the study 'Modernization of Rail Route 10' which aims to help the Kosovo Railways to attract the interest of international financing institutions for further pre–investment studies. The overall objectives of the study are to prepare a package of short term improvements, which comprise of repair programmed for track and structures to bring the line to the designed speed and to draft a medium–long term development scenario that will include higher line speed up to 160 km/h and electrification. Following the status and objectives of this study, including the outlines stated in the defined the reference options as follows:
· option 'short term ', as 'option 1', and
· option 'medium–long term', as 'option 2'.

Keywords: railway infrastructure, higher speed, traffic load, safety, environment.

1 Introduction

Rail Route 10 'North–South' traverses over Kosovo territory from the border with Serbia (station Leshak) to the border with Macedonia (station Hani i Elezit). The line is 148km long within the territory of Kosovo. The line was originally built in 1893 and it is not electrified up to the date. The last track renewal along the line was carried out in period 1974–1975. Rail Route 10 sustained the highest rate of damages in period 1990–1999. So far, these damages have been partially repaired. The level of regular superstructure and substructure maintenance in that period was reduced to a minimum resulting in sub–standard condition of the line with the maximum speeds reduced to 60–70kph along the line. In some specific cases, the maximum speed is reduced to even 20kph because of safety reasons (sections with tunnels).
The line justifies the intervention, since 35 years elapsed from the last track renewal. Superstructure components are worn–out, which led to general reduction of speed limits to 60km/h along the whole line, although major part of the line was originally designed for 100–120km/h, except on hilly sections where the maximum designed speed was 70km/h. Substructure components also require rehabilitation and improvements, since 15 bridges have C4 load classification (less than D4 required) and 13 tunnels have lining rehabilitation problems, which led to further speed limits of 20km/h in four extreme cases due to safety reasons. Furthermore, 5 tunnels on section Leshak–Mitrovice require cross–section improvements in order to eliminate technical and operational restriction for high–cube containers. Fushe Kosove junction (stations Fushe Kosove and Miradi) is not equipped with interlocking at all, although it is the main railway junction in the country. A lot of efforts were implemented by KR on introduction of the CTC along the whole line, but there are still substantial requirements in other stations to enable the full integration. There are 105 level crossings, of which 16 are interlocked and this presents a special problem for further treatment.
The study drafted the alignment for do–maximum option, which would be 130.5kms long (approx. 20kms shorter than the existing one), with 9.2kms of bridges and 14.8kms of

tunnels. Each bridge and tunnel was elaborated as a single–structure for a double–track line, which substantially affected the reduction of the estimated construction costs. Along with the substructure, superstructure, signaling (interlocking, telecommunication and level crossings) and electrification components, the total investment costs are estimated at 513.1 million.

2 Background and objectives of the study

The bases for implementation of this project are the identified core railway network within the activities of SEETO (South–East Europe Transport Observatory). The purpose of the SEETO is to promote the regional cooperation in development of multimodal core regional transport network of the South–East Europe, as well as the support to the implementation of investment programmers within this network. One of the main results of the SEETO activities is the identification of such network, including the core railway network.
SEETO's core railway network are railway routes taken from the concept of the Pan–European Corridors and additional railway routes, which are assessed as important for development of multimodal core regional transport network of the South–East Europe.
Under this concept, Rail Route 10 presents the existing railway line in total length of 252kms with general orientation Kraljevo (Ser)–Pristine (Kos)–Gorce Petrov (Mcd). Following this concept, Government of Kosovo drafted the Multi Modal Transport Strategy, addressing this to the Rail Route 10 (148kms) located within Kosovo territory (Leshak–Hani i Elezit/North–South railway line).
Under the framework of former Yugoslav Railways network, Corridor X connected Belgrade via Lapovo and Nis with Skopje (MKD). Rail Route 10 branched in Lapovo between Belgrade and Nis, forming another route to Skopje: Belgrade–Lapovo–Kraljevo–Fushe Kosove–Skopje. The design speed along Rail Route 10 was 100–120km/h between Mitrovice and Gurez, where the Line runs in a valley with wide or no curves at all and without substantial gradients. South of Gurez and north of Mitrovice to Kraljevo, the Line runs in canyon areas with narrow curves of 250–300m radius, 17–19‰ gradients and many tunnels and bridges. The design speed along these two sections of the Line is 60–70km/h.

Figure 1 Core Railway Links in the SEETO Network

Figure 2 Railway Network in Kosovo

In 1980–ies, the modernization of the Line started with new signaling systems installed ('Ericson' along Rail Route 10). The signaling systems were designed and prepared for operation under the electrified railway line conditions. The electrification of the present Rail Route 10 was studied but it was never implemented, so the Line remained non–electrified. In that period, Rail Route 10 served mainly the mining and metal industry located between Fushe Kosove and Kraljevo. It was also used for transit trains throughout Kosovo to Skopje and further to Greece. Irrespective to Corridor x, Rail Route 10 has not received much attention so far and has suffered of war damages and political troubles. In the recent years, Kosovo railways have gradually repaired the war damages and restarted a limited train service for passengers and gained a growing number of cargo transports. At the moment, restructuring process, where the next step will be the separation of the infrastructure from transport operations.
Kosovo is a partner in SEETO and will be a signatory to the new West Balkan Transport Treaty. The treaty requires open access and interoperability to be achieved, which is one of the important issues for consideration under this study.
The Project has to reach the following objectives for both cargo/freight and passenger transport:

- to provide reliable access to railway services customers with relatively high availability of infrastructure capacity (one train path per hour);
- to provide certain quality in signaling and telecommunication components of the railway infrastructure for facilitation of operations along the line in accordance with the contemporary standards recognized by certain international institutions and safety integrity level requirement;
- to eliminate physical bottlenecks for safe and regular railway operations, including the contemporary transportation facilities such as Ro–La, high–cube containers, etc.;
- to provide higher level of service (standards for the upgrade of the line up to 160km/h) including the electrification, once this upgrade is justified by traffic demand.

Objectives of the Study are the following; to prepare short term improvements, which comprise to bring the line to the designed speed and to draft a medium–long term development scenario that will include higher line speed up to 160 km/h and electrification.

3 Option 'medium–long term'

This medium–long term option n includes the maximum scope of interventions, which refers to the reconstruction of all infrastructure components in order to reach maximum speed at 160km/h along Rail Route 10. This option also includes construction of the double–track line and electrification of it for the stated speed.
This is considered a medium–long term option and a conceptual technical design has been pre–formed within the scope of the study, as part of the pre–feasibility assessment. This option includes the designed speed of 160km/h for passenger trains and 120km/h for freight trains along the Line. This requires substantial rectification of the sections of the Line placed in the hilly areas (Leshak–Mitrovice and Gurez–Hani i Elezit). Besides that, this option requires the following observations in terms of track geometry against the estimated investment costs:
· construction of single structures (bridges and tunnels) for carrying the double–track line,
· designed speed for running lines in stations,
· status of level crossings.
Interlocking and telecommunication equipment requires certain adjustments in comparison to 'do–something' option. Besides the previously identified activities, it will be necessary to install GSM–R communication system and to provide protective installations for electrified lines on the equipment, including the 100% GSM signal coverage along the Line.
The electrification of the Line requires installation of substantial equipment (OCL, substations, etc.) for a double–track line system.
So, option do–maximum creates the substantial upgrade of the Line and makes it identical to the standardized infrastructure components of majority Corridor railway lines under the SEETO concept.

4 Technical Options

The track renewal activity along railway line Leshak–Hani i Elezit has been already assessed as necessary, since the last renewal was carried out in mid 1970–ies and the condition of the track components requires this activity in order to prevent its further deterioration and to meet expected traffic demands. The experts assessed two alternatives for the track renewal, which are based on different track components. One alternative is based on rail type UIC60E1, reinforced concrete sleeper 2.60m long, elastic fastening and eruptive stone ballast, whereas the another alternative is based on rail type 49E1, reinforced concrete sleeper 2.40m long, elastic fastening and limestone ballast. The proper attention is also given to the situations at tunnels, bridges and stations.

5 Superstructure

5.1 Rails

There are two types of rails, which were assessed by the experts, 49E1 and UIC60E1. There are several technical and operational elements, which have the influence on selection of a rail as follows:
· type and annual volume of traffic,
· axle load,
· speed of trains, especially in curves affecting the cant,
· curve radius,
· impact of rising and falling gradients,
· type of rolling stock.

The expected traffic along Rail Route 10 in Kosovo is mixed with annual volume of traffic in range of 7.5–11 millions gross–tons. For such traffic volume range, experience showed that the expected lifetime of rail UIC60E1 is 5 years longer than of rail 49E1. That is based on the period between two complete track renewals, which is 25 years (maximum 30 years) for UIC60E1 and 20 years for 49E1 (maximum 30 years).
The expected axle load along Rail Route 10 will be 22.5 tons and classified as D4 category. Both rail types meet this requirement but rail UIC60E1 can bear 25 tons axle load, which puts another important advantage to this rail type. The fostered trend of productivity increasing in freight traffic specially, asks for further improvements of maximum axle loads on existing infrastructure, at least along the major corridors or lines.

5.2 Sleepers and fastening

For the open line, except in tunnels and steel bridges without the ballast, there are two type of sleepers assessed. The first one is the concrete sleeper of type 'JZ 70', which has already been used along the line. This sleeper was 2.40m long and fastened by 'K' fastening to rail 49. Another one is the monobloc reinforced concrete sleeper, which is 2.60m long. The procedure for assessment of suitable sleepers and fastening is similar to the rails. It also includes the same technical and operational elements as for rails, because it is required for sleeper to go in combination with the rail and the fastening. Longer reinforced concrete sleepers with higher support surface are proven as more suitable for amortization of static and dynamic stresses caused by train movements in general.
Based on Rulebook 314, reinforced concrete sleepers can be installed in the track with curves of radius equal–higher of 250m. Following this Rulebook, it is compulsory to install wooden sleepers in tunnels and on bridges without ballast. So, tunnels and bridges without the ballast will have sleepers made of oak with dimensions 26x16x260cm, which was originally foreseen by the Main Design made in 1984, but was never implemented.

6 Electrification of the existing line

In addition to the aforesaid components, the experts considered the electrification of the existing line based on the previous technical elaborations.

6.1 Overhead Contact Line

The contact wire is of Ri 100 type, no. 65. At locations of pylons, the stitch–wire suspension, in length of 12.5m, is foreseen in order to implement more uniform elasticity of the OCL in combination with the pantograph. The tensioning is separated between the contact wire and carrying cable. The total length foreseen for the electrification in terms of the OCL is 179kms, which includes the open line and tracks in stations along the line.

6.2 Power Supply Plants

The substations are foreseen at locations Vallac, Miradi and Gurez. Also, 4 locations of the sectioning point with neutral line are foreseen with 4 switches in order to enable parallel power supply of the con– tact wires on both tracks and longitudinal separation of the sections.The disconnecting switches for power with engines are foreseen in stations. The power supply along the line has to be considered for 2x25kV system.

7 High speed track and structure solutions

Considering that the existing technical elements of Rail Route 10 do not meet conditions for a train speed at 160km/h, the experts designed the variant of the alignment at the conceptual level with more favorable geometry elements as a double–track line. The digitized topography maps in 1:25,000 scale were used, from which the digital terrain model was created with sufficient precision for this level of design.
The experts used design standards taken from former Yugoslavian Railways, which are in principle based on several Rulebooks, such as 314 (superstructure) and 315 (substructure), standard for a railway tunnel design, etc. The experts also used other international standards, such as European Norms for track geometry for instance, in order to obtain the consistent technical solution, as much as possible, at this level of design.
The following geometry elements of the alignment have been selected by the experts for design of the double–track railway line at designed speed 160km/h:

· minimal horizontal curve radius: R=1,100m,
· minimal length of the transition curve: L=240m,
· maximal gradient: i=15‰,
· distance between centers of track: 4.00m on open track and 4.75m in stations.

The maximum development is a medium/long term scenario, in order to achieve double track, electrified railway line with maximum speed of 160km/h. According to the stipulated in the first paragraph of Article 5 and Annex I of the Law on EIA, for this scenario, which includes construction of new lines for long–distance railway traffic, the EIA procedure is obligatory. Scoping Report shall include a description of possible railway line alignment alternatives, a description of significant impacts of new railway line construction on the environment, reasons for identifying these impacts and a description of mitigation measures. Of course, the project described in this scenario will have significantly stronger impact on the environment than previously described scenario track overhaul. Therefore, the experts should use all available data about the environment (its sensitivity, simple observations and results of measurements), as well as all their knowledge and practical experience to recognize the significance of environmental impacts during the railway line construction and operation.
During construction and operation of such a big infrastructure project, the most significant impacts could be expected on settlements and population, surface and ground water, use of land and spatial organization, agricultural soil, flora and fauna. The impacts on other infrastructure systems (both, existing and planned), protected nature areas and cultural and historical heritage should also be carefully examined in the following stages of the project.
The significance of some impacts can be different in different phases, so mitigation measures, where negative impacts are identified, should be defined for both, construction and operation phases of the project. For example, mitigation measures related to the air quality will probably be required during the construction of electrified railway line, but impact of an electrified railway line in operation on air quality is insignificant and it will probably not require mitigation measures. Moreover, noise and vibrations during the construction are mostly caused by construction machinery in operation; On the other hand, noise and vibrations during the railway line in operation are caused by the train movement, so the mitigation measures should be addressed properly.

8 Conclusions

The study has been already classified as of international importance through the SEETO's / South East Europe Transport Observatory/ Core Network as a 'Route'. From the technical point of view, the short term interventions are track renewal with the improved superstructure components along the whole line and 3 station tracks, repair of tunnels (including the improvement of cross–sections in tunnels), repair of bridges (including the improvement to D4 classification, and rehabilitation of drainage and track bed), installation of electronic interlocking with the axle counters in Fushe Kosove junction, completion of the telecommunication equipment and rehabilitation of level crossings.

Although general trends in passenger traffic on Kosovo railways network indicated decrease in period 2000–2008, performance along rail Route 10 indicates gradual recovery. However, if improvements are not carried out on rail Route 10 under do–maximum option, the passenger traffic projection will stabilize over the year and potentially loose the traffic because of expected improvements in roads sector. The passenger traffic projection indicates the performance at 162.6 million pass/km and 168.2 million pass/km in 2025, and 243.3 million pass/km and 251.7 million pass/km in 2042 respectively to the options. This also indicates a relatively small difference in traffic contrasted to differences in project options and their investment costs.

Oppositely to passenger traffic, freight traffic on Kosovo railways network indicates substantial recovery in the recent years, including the performance along rail Route 10. However, the improvement options along rail Route 10 would not substantially contribute to the increase of this traffic component. This is also reflected by the fact that the freight traffic will continue to be highly dependent on development of the industries in the country, which will use the railway transport service regardless to the infrastructure improvements on railways and roads

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