



## MAIN WORKS FOR CONSTRUCTION OF RAILWAY BYPASS AROUND NIŠ

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### Abstract

Railway bypass around the city of Nis represents the first phase of a long-term solution for modernization of Nis junction. By the preparation of the project documentation and then construction of the railway line, all non-conformities will be solved during the urban and demographic development of the city of Nis with investment in the road and railway infrastructure. Important questions which were solved during the design phase by active collaboration with the Beneficiaries were following: fitting of the bypass line to the five existing railway lines, fitting into the three existing stations (Niš Marshalling, Crveni Krst and Sićevo), construction of new establishment (stations: Niš Sever, Pantelej, Vrežina and temporary establishment – junction Prosek) and works on the adjustment between new and existing infrastructure. Designer's approach and proposal of the operational plan for construction of railway bypass with road traffic safety during the works are the subject of this title.

*Keywords: railway bypass, operational plan, construction, works*

### 1 Introduction

Finalization of the General Transport Master Plan in Serbia until 2027 with the National Strategy for Economic Development of Serbia will provide investments in transport corridors in order to integrate the transport system of Serbia into the European system. In that way conditions for effective participation of Serbian economy in the European market will be created. Geographical position of Serbia is of great importance in the formation of traffic flows as it lies on the main routes linking the countries of Western and Central Europe with the countries of South-East and the Middle East that is both comparative advantage and interest in ensuring the efficient flow of people and goods. Construction of railway bypass around Niš and its connection with existing railway lines in the country and abroad (to Belgrade and towards Skopje and Sofia), as well as the electrification of Niš – Dimitrovgrad will enable the association with TEN-T network.

### 2 The current state of infrastructure in the corridor of railway bypass

In relation to the international railway network (Figure 1), Niš represents the point of separation or merger of two main lines of international E-75 Budapest – Subotica – Belgrade – Nis – Skopje – Athens and E-70 in Paris – Turin – Sežana – Ljubljana – Zagreb – Belgrade – Nis – Sofia . Railway Trupale – Niš Ranžirna – Međurovo and Crveni Krst – Niš Ranžirna are also the main lines and railway Crveni Krst – Zajecar – Prahovo Port is regional railway according to the Regulation on the classification of railways art. 6 para.2 Railway Law (Official Gazette of RS, No. 45/13) and art.42 paragraph 1 of the Law on Government (PG RS No.55/05 and 71/05 – correction 101/07, 65/08, 16/11, 68 / 12 – U.S. and 72/12).

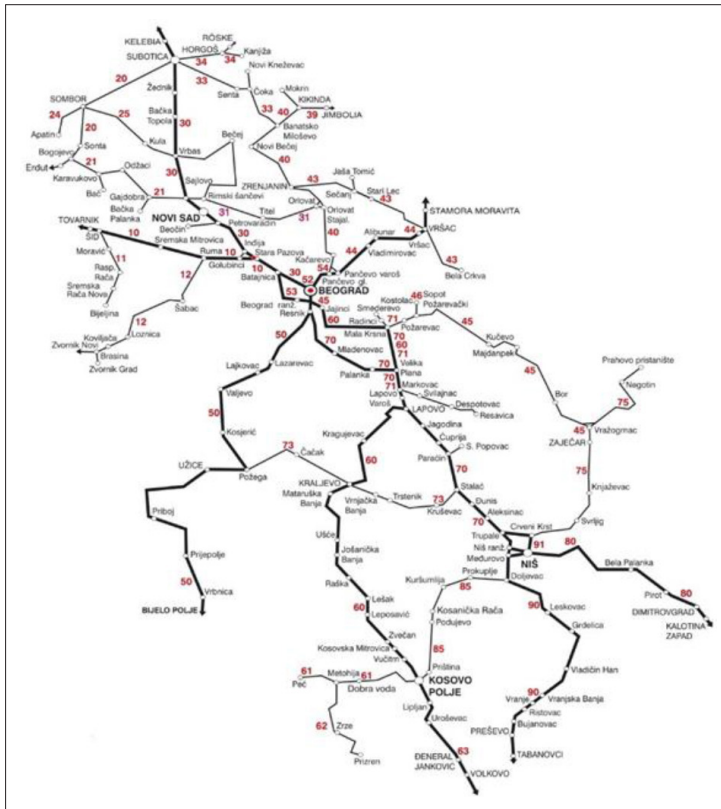


Figure 1 Railway Network in Republic of Serbia

The existing established places are shown below:

- **Niš Marshalling yard** – Station is located west of the city of Niš, between the village Popovac and airport Constantine the Great. It is oriented in direction north – south, with the tracks divided into four groups:
  - Arrival-departure
  - Transit
  - Marshalling – departure
  - Station

Apart from these groups of tracks, the station Niš Ranžirna station consists of a locomotive depot and wagon workshop with an additional equipment.

- **Crveni Krst** – Station is located in the industrial zone of the city of Nis, outside the central zone of the city. Passenger, freight and local freight work is carried out here and it has a functional connection to the depot and industry.
- **Pantelej** – Halt belongs to the open line of the railway route to Matejevac. The halt is in a curve with the existing low platform. It serves for local passenger's traffic.
- **Prosek** – Halt belongs to the open line to Dimitrovgrad after the highway goes to station Sićevo.
- **Sićevo** – Station is located in Sićevo Gorge between Nišava and the main road Niš – Dimitrovgrad. Until 2009 there were three tracks that were dismantled. Station is in operation, there is a station building and a warehouse with warehouse ramp.

The year of building railway lines and existing Railway Network are shown in Figure 2.

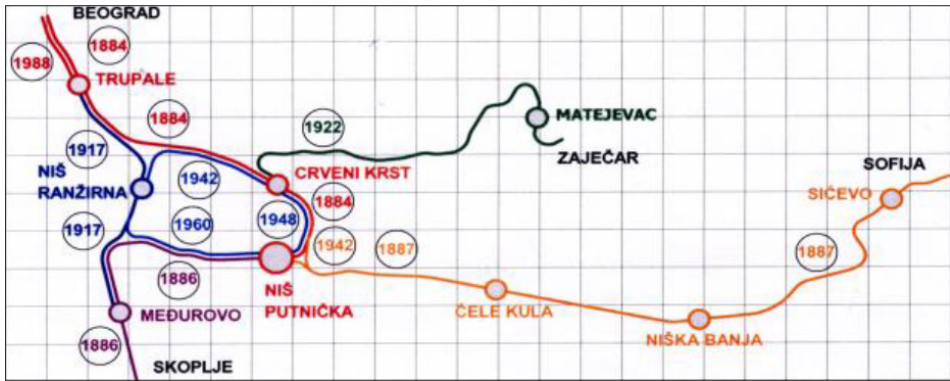


Figure 2 Existing state of railway line in Niš

From the aspect of the road traffic, Niš is the crossroads of international regional and local road traffic. Sections of the international road E-75 (M-1) and E-80 (M-1.12) are the backbone of the bypass roads around Niš. The construction of the highway E-80<sup>th</sup> is in progress. From Niš are separating 11 routes on which bus transportation is organized. From the aspect of air traffic, the city airport “Konstantin Veliki” is qualified for receiving medium aircrafts. “Konstantin Veliki” is the second category airport, and it is airport for regular and charter flights for the passengers of Niš and the region, and it serves as an alternative airport to Belgrade, Skopje and Sofia. Using of the runway is limited by the existing electrified railway.

### 3 Modernization – railway bypass around Niš

#### 3.1 Alignment

The alignment of the single-track railway bypass is designed with a length of 22.4 km, with a starting point in the Niš Ranžirna station. Editing of the existing route Niš Ranžirna – Crveni Krst, which was taken over bypass railway line, is carried out in order to meet the requirements of Niš airport (providing the space for the extension of the take-off and landing track and also the space for lighting of airport Konstantin Veliki). Reconstruction of the entrance Nis Ranžirna station is completed. Further, the new route guided by rim of the village Popovac until the new Niš Sever station. In this part of the route, bypass lines are largely in the cut corresponding to the request of the general visibility of the international airport in the area of take-off and landing tracks.

Niš Sever station on km 3+000 is located on the north side of the city of Niš. The station is designed along its length in the horizontal direction and in accordance with the traffic-technological requirements, taking into account the territorial limitations. The total length of the station is 1542 m. For the execution of all technological tasks, the final solution for the space of double track railway bypass, the station Niš Sever is designed with 7 tracks and 2 platforms. The first phase of the construction of the Niš Sever station includes the construction of 4 tracks, station building, plateau, access road and parking, underpass and platform no. 2. In the new station building are envisaged rooms for the signalling and interlocking devices, telecommunication devices and power devices.

The open line of the bypass from exit of Niš Sever station in the direction of the village Pantelej is projected. From km 5+270 to km 6+898 (entrance to the Pantelej station), bypass line is largely in the embankment with the elements of layout, and it is designed for speed  $v = 120$  km/h in accordance to current field possibilities.

The topography of the terrain, interoperability requirements, the technological requirement for work in the station all give input for defining length of the Pantelej station (1855 m). In traffic terms, it is an interstation and it regulates train traffic on the lines of Niš – Dimitrovgrad – border and (Niš) – Crveni Krst – Zaječar – Prahovo or onto the bypass line. The station Pantelej performs separation of the directions Dimitrovgrad and Zaječar and it is open for operation in passenger suburban, local and city traffic. The entrance of Pantelej station is designed in embankment, the exit is designed in the cut with retaining walls on the side of the both railway line to be aligned to existing settlement.

The alignment of the railway bypass from the exit of Pantelej station (km 8 + 753) to km 18 + 331 (near the junction Prosek) is designed with elements of the plan for the speed  $v = 160$  km/h. The Radius of the designed curve is  $R = 2000$  with transitions.

Vrežina station is designed on the km 14 + 600, so as to be open for operating in the passenger suburban, local and city traffic, but not to work for cargo traffic. Length of the station in the final stage is 1319 m. The first phase of the construction of the Vrežina station includes the construction of two tracks, station building on two levels with rooms that are adapted to the technological requirements, plateau, access road and parking, underpass and platform No. 1. Tracks constructed in the first phase of the official Vrežina site will be assigned function of the junction point.

The alignment is designed from the exit of the Vrežina station to the Prosek junction with the River Nišava, in order to avoid keeping the route through the hill. Concerning the sub-section, the technical solution with retaining walls (a distance of about 200 m) is adopted for the protection of the river Nišava, on one hand, and on the other because of the cuts in the hill. At the same time on that subsection, the designed elements of the plan correspond to the speed  $v = 120$  km/h and match the existing railroad Niš – Dimitrovgrad speed of 80 km/h. Prosek junction point is a temporary solution until the completion of construction and modernization of railway line number 22, and is designed in the km 19 + 304 bypass rail. In the new building, on the left side of the tracks, internal signalling and interlocking devices, telecommunications and power devices are located, and the access to the facility is provided temporarily from a state road.

At km 20+000 railway bypass fits into the reconstructed railway line Niš – Dimitrovgrad (km 14 + 258) in accordance with the Detail Design for the electrification of Niš – Dimitrovgrad and which goes to the Sićevo station (PS entry points) where is the end point of this Project. Railway bypass has influenced the existing tracks in the corridor, and they are reconstructed in accordance with the new alignment:

- 1) Subsection rail E70/85 Beograd-Mladenovac-Lapovo-Niš—Preševo – state border (Tabanovce) section Trupale – Niš Putnička – Medurovo – main (line no.3) on the bypass rail corridor around the Niš is necessary to be reconstructed in the length of close to 4 km.
- 2) Subsection rail Trupale – Niš Ranžirna – Medjurovo – main (line no. 30) on corridor of bypass around Niša is necessary to be reconstructed in the length of close to 1,8 km.
- 3) Subsection rail Crveni Krst – Niš Ranžirna – Medjurovo – main (line no. 17) ) on corridor of bypass around Niša is necessary to be reconstructed in the length of close to 2.9 km, more precisely the existing railway route 17 from the station Niš Ranžirna (km 3+232 = PS 3) to the station Niš Sever the length of 1.7 km is dismantled.
- 4) Subsection rail Crveni Krst–Zaječar–Prahovo Pristanište – regional (line no. 38) on corridor of bypass around Niš is necessary to be reconstructed in the length of close to 4.5 km.
- 5) Subsection rail Niš – Dimitrovgrad – državna granica (Dragoman) (line no. 22) international main lines are necessary to be reconstructed in the length of 0.5 km on section at Prosek junction point.

Note All crossings with planned/existing roads are designed separate grade – underpasses and overpasses. Bridges, culverts, retaining walls, noise barriers are designed and they are contained in this Project.

## 3.2 Systems

**Power supply of catenary wire** of railway bypass track around Niš is provided from the existing electric traction substation (EVP) Niš. Based on preliminary electric estimation, it is necessary to increase the power EVP, and keeping in mind the age of the existing EVP Niš, a complete overhaul of the plant is planned. For integration of newly designed catenary wire of bypass track around Niš in the existing system of power supply and sectioning, the construction of facilities for sectioning PS Pantelej is planned. Electrification of this part will be finished in Vrežina station, where PS / PSN Vrežina will be built.

### Catenary wire

Catenary wire on newly designed railway bypass track around Niš is planned with chain-compensated contact line, composed of the contact wires and rope carrier. Contact line with “Y” wire is projected, which corresponds to the driving speed up to 160 km/h. Also planned are the support structures of catenary wire in two forms: cantilever poles from steel (U) profiles and grid steel structure portals.

One or both driving rails of each track in stations and both driving rails on open track are used as a returned line for traction current. The continuity of the return line of catenary wire is provided by the mutual electrical connection of neighbouring, non-welded rail fields using rail breakouts. To reduce voltage drop and equalizing the potential in return line, inter-rail and inter-track joiners between non-insulate rail is placed. Earthing of support structures of catenary wire is predicted with single connection on closer non-insulated rail. For longitudinal supply and sectioning of catenary wire, isolators with motor drives are planned, for the purposes of cross-sectioning in stations and isolators with manual drives.

### Remote control

An installation of new equipment for remote control of newly designed traction power plants in CRU Niš and in itself facilities is planned, as well as the replacement of the existing equipment. It is necessary to ensure sufficient capacity of transmission routes and compatible devices for transfer.

### Power supply of train station with electrical energy

In design of railway Niš Sever, Pantelej and Vrežina stations, a construction of one transformer station is planned, with 10/0,4kV adequate power and connecting lines 10kV. From this transformer station it is planned power supply of signalling – interlocking and telecommunication devices, external light and consumers in the station facility. Power of switches heater and backup power of signalling – interlocking and telecommunication devices, it is planned a construction of the new poles of transformer stations with 25/0,23kV adequate power, which is connected to overhead line of catenary wire. Plan is to relocate and protect all of the underground and over ground electro – energy lines, which are in collision with newly designed bypass rail route around city of Niš.

### Railway Signalling and Interlocking facilities and devices

Preliminary Design has processed the following things: way of ensuring the new and reconstruction of the existing railway stations and interstation distance in zone of Niš railway bypass, in accordance with the requirements defined in standard CENELEC EN 50126, EN 50128 and EN 50129 for work in system with electric traction of 25kV, 50 Hz; technical solution of equipment with signalling and interlocking devices for new stations, with HMI device and interstation distances ensured with devices for centralized automatic railway block, or interstation dependence, reconstruction of existing signalling and interlocking devices, and also installation of ETCS level 1 devices .

The equipping of the stations Sever Niš, Pantelej and Vrežina is designed with new interlocking equipment using the technique of electrical HMI control panel with the centralized setting switches and automatic reorganized routes plan through station area, as well as the elements of the European Train Control System (ETCS) level 1.

In accordance with the new arrangements of tracks in Niš Ranžirna station and the new interstation distances design solution in Niš Ranžirna station, dismantling, reparation and re-mounting existing systems is planned. The Centre of Telecommand for traffic also plans an alternation of panel and internal central device according with new track situation of railway junction and bypass Niš.

### Telecommunication facilities and devices

With construction Design of bypass railway, electrification of system 25 kV/50 Hz is planned, which means that a network for track and local cables must be built.

With regard to the requirement for transmission of information and the current state of technic, it is necessary to provide railway copper cables as well as fibre optic cables. The installation of fibre optic cables without metallic elements with single-mode fibre is also anticipated. Local cable networks should involve all participants in the regions of stations in the track telecommunication system.

Dispatching systems and track telephony should enable connection to the regulation of traffic and service connection. Radio dispatching system is designed on the basis of legal obligations that all tracks with speed greater than 100 km/h must be equipped with radio dispatching system.

In accordance with the expected needs of the Niš Sever, Pantelej and Vrežina station, platform (outgoing and incoming) information boards are planned. Planned sound system is designed for transmission of voice information about arrival and departure of trains. Planned for sound distribution of platforms are horn speakers which are mounted on poles or canopies at the height of about 4 m or on the facade of the building. Horn speaker and projectors for outdoor use are resistant to flame. The function of the video supervision system in the official places is to protect telecommunication equipment for informing passengers, placed outside the building and monitoring the movement of passengers along the platform. Central device of system for automatic fire alerts is anti-fire panel with single addressable loop, which connects detectors and modules inside the building. Central device is connected with an alarm telephone machine for the remote signalling of alarms and faults. The Central is set up in a dispatcher room.

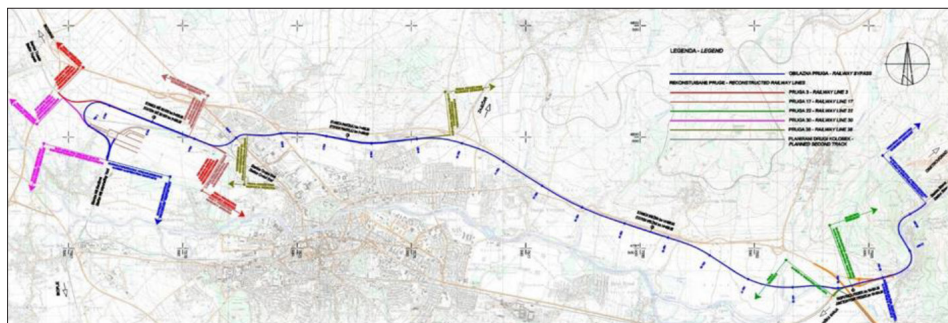


Figure 3 New railway bypass alignment



## 4 Organization of construction works on bypass track and reconstruction of existing track

Proposal of construction is given under the assumption that the selected contractor will be able to make of parallelization of works in first phase, in order to shorten the construction period and enable the work railway and road traffic. In below are listed the main works, more precisely:

- Construction of the railway bypass (preparatory works, substructure with drainage, superstructure, structures, works on Catenary wire, Signalling and Interlocking and Telecommunication), facilities are planned for the observed section.
- Reconstruction of railway lines (largely due to changes in the route of the preparatory work, substructure with drainage, superstructure, works on Catenary wire, Signalling and Interlocking and Telecommunication), as well as the facilities which are scheduled on the observed section. On places of fitting reconstructed track in existing condition, it is necessary to include works of superstructure and catenary wire and also linkage of Signalization and interlocking systems)
- Road construction and deviations (substructure and superstructure of route)
- Construction of the station and complete infrastructure (track situation of superstructure, buildings, underpass platforms, installations)

Division in two phases is the result of the road and rail traffic on goings. Therefore, it is:

- 1) The first phase of works and its total length is submitted so that the traffic (road and rail) will be in function for as long as it is possible, while the construction works are taking place simultaneously in several points, which will, of course, depend on the availability of jeep on the field and contractor's machinery.
- 2) The other phases of the works on the subsections and the length of their work will be in accordance with the proposal of the traffic during the works.

### 4.1 Description of phases

#### I. Phase

Parallelization of works on the subsections that are completely independent. There are proposed subsections so that rail traffic functions undisturbed on the railway lines 3, 17, 30, 38 and 22.

- 1) Subsection 1 reconstruction of the track 3 (new route) Trupale – Niš Sever (chainages of track 3 – beginning of works at km 0+200 entrance in Niš Sever station km 1+500) in the length of 1300 m.
- 2) Bypass track of subsection 2 Niš Ranžirna – Niš Sever (chainages of bypass track from km 1+300 to Niš Sever station km 2+400) in the length of 1100 m
- 3) Niš Sever station subsection 3 (chainages of bypass track from km 2+400 to km 3+500) with works to protect the current collector and other installations (part of the station that is in the corridor lines 3 and 17 work in the phase II because of the traffic)
- 4) Bypass track – Subsection 4 (bypass chainages from km 4+450 to km 5+000 ) which includes a new object
- 5) Pantelej station – Subsection 5 (chainages of bypass track from km 6+700 to km 7+400) new railway line is higher than the current – EMBANKMENT – station building and access to the previously done access road as it is scheduled in the plan of the city of Niš. Subsection 6 (chainages of bypass track km 8+650 (behind of retaining wall) to km 9+400) new railway line 38 will be done in length 700 m in the same corridor of railway bypass around Niš and facilities under those subsections.
- 6) Construction of the bypass rail subsection 7 from km 9+400 all the way to Prosek to km 19+100 together with Vrežina station, facilities that are provided, in Vrežina station pay

attention to the protection of power transmission line, in part near the Nišava river take into account the work which needs to be done on the retaining walls and coastal fortification in a distance of about 200 m)

- 7) Prosek subsection 8 includes the following works of construction:
- 100 m track (reconstruction of track 22 outside the profile of existing lines 22)
  - bypass track from km 19+450 to 19+750
  - deviation / a temporary road in the length of 150 m
  - the access road from traffic roundabout to Prosek urban area in length of 800 m
  - traffic roundabout south with facility, overpass and part of the road up to the integration into the roundabout Sever.
  - roundabout Sever could be done by half without the suspension of road transport

**Note:** During the first phase all tracks and road traffic operate.

## II. Phase

Rail traffic is diverted from the track 3 to track 30, the traffic on the track 17 is abolished the scope of the construction work on subsection 9 Niš Sever – integration to Crveni Krst:

- completion of the Niš Sever station from 3+500 to 3+870 by track situation
- bypass track from km 3+870 to 4+450
- reconstruction of the track no. 3 with the length of 850 m
- reconstruction of the track 17 with the length of 850 m
- production of the retaining walls and buildings
- integration into the existing condition in Trupale and Crveni Krst direction, track 3
- integration into the existing condition in Crveni Krst direction, track 17

## III. Phase

Rail traffic is diverted from the track 30 and goes on new track 3 (reconstructed in the previous phases). The scope of the construction work of subsection 10 Niš Ranžirna – exit:

- Dismantling of the existing track 3, 30, 17
- Reconstruction of the Niš Ranžirna station,
- Reconstruction of the track 30 and matching with the existing condition to Trupale
- Reconstruction of the bypass track by km 1+300

## IV. Phase

Railway traffic – Track 38 in this phase must be closed. Subsection 11 Crveni Krst – Pantelej and the part of Pantelej station

- from km 5+000 to 6+700 of the bypass track and the reconstruction of the track 38 are in the same corridor – EMBANKMENT
- from km 7+400 to 8+650 (chainages at the bypass track) – bypass track and the reconstruction of the track 38 are in the same corridor – CUT – retaining walls

Material from the cut goes to the embankment, and for the construction of embankment materials from landfill are used, which was previously made in Pantelej station – phase I on km 6+800 (Excavation from Niš Sever). After this phase, Pantelej station will be completed and connected with track 38.

## V. phase

Railway traffic – In this phase track 22 must be closed. Subsection 12 from km 19+100 to 19+450- construction of bypass track. Two options are available at the junction point Prosek:

- the re-routing of road traffic
- closure of road



In both cases it is necessary to close the track 22. During the closure of the track, the works on Prosek junction point within 350 m of bypass track, temporary road crossing and road length of 200 m are performed. The integration is performed from km 20+000 in track 22. This means that the closure of the track may take a maximum range of 10-15 days.

## 5 Conclusion

Organization plan for construction depends on the phase project documentation – it will give overview of the time required for construction in accordance with the time schedule of activities proposed during the design. For the purposes of the dynamic plans preparation of in the form of Gantt chart, there are used structural-logical unified position of works. They are presented at the level as total and individually divided to the preparation, construction, electrical, architectural works and finishing works. Further, lower levels of activity with proposed duration of activities (according to experience) are also presented in Operational plan. This project is intended to be simultaneously engaged in two, and some of mentioned sub-section in a given time in three work brigades, both on the substructure and superstructure. According to the developed dynamic plan (Gantt chart), the total duration of work on the project is 700 working days.

Detailed technology of works, corrections on practical effects of machine and equipment, detailed Gantt chart of works will be prepared by the Contractor and accepted by the Investor, with special conditions for safe functioning of the railway and road traffic. After approval of that by the professional services and real needed time for realization of this project will be set.

## References

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- [6] Other technical regulations and standards for preparation of the project documentation for Modernization of Railways – Project documentation for the railway Bypass around Niš