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REVIEW OF THE REMETINEC ROUNDABOUT RECONSTRUCTION PROJECT IN ZAGREB

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Abstract

A very complex problem of the main roundabout projects development concerning the solutions given in the location permit and preliminary design, as well as new knowledge about communal infrastructure is given. Based on the new geodetic survey, subsequent requirements of the audit, investors, and obtained special conditions, it was necessary to adapt the technical solutions of the preliminary design. Particularly demanding work was defining the protection of the construction pit. The solution foreseen by the preliminary design and location permit for the works to be carried out under the traffic could not have survived, because of the technological reasons for the construction of the underpass and the very complex situation with the installations at that location. These facts required a complete suspension of traffic at the site and finding solutions to the temporary traffic regulation around the site. This was an unplanned and very demanding moment, given that the daily traffic at the intersection was around one hundred thousand vehicles a day. The solution to this problem was found in the construction of a temporary road, which conducts traffic through and around the construction site, thus enabling the smooth technological and technical organization of works while simultaneously conducting public and individual traffic to and from the city.

Keywords: project modification, construction works, traffic organization

1 Introduction

In the fifties of the last century, the formation of the town south of the Sava began. Urbanized settlements are being built and the old villages in their surrounding are growing rapidly and urbanizing. The Sava Bridge, built in 1938, soon became insufficient for traffic jams. To relieve traffic in the western part of Novi Zagreb - the western entrance to the city in 1981, the Jadranski bridge and a roundabout intersection connecting Jadranska Avenue and Dubrovnik Avenue, Remetinečka Road with Savska Street, the so-called "Remetinec Rotor". The roundabout ("Rotor") with a radius of 74m was built at the level of +1 concerning the surrounding terrain. The +1 level is conditioned by the planned passage of the tram line at ground level, which was built in 1984. The roundabout is designed for a traffic of 50,000 vehicles per day, but with the construction of the Lanište settlement and the sports hall, and the Arena shopping center during the 2000s, the volume of traffic doubled. Roundabout has become one of the busiest traffic intersections in the city of Zagreb, with a traffic load of more than 100,000 vehicles per day, on which one traffic accident occurred on average per day. In addition to the high traffic load, the position of the roundabout, elevated concerning the access roads, is an additional cause of a large number of traffic accidents. The first study of the roundabout reconstruction was made in 2007, and two years later a proposal was selected with an additional level of crossing denivelation, in such a way that the traffic in the east-west direction was lowered to the level of -1 [1].

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As part of the reconstruction project (1), the geometry of the inner roundabout radius is retained, but the traffic lights are added, (2) overpasses on the northeast, northwest, southwest and southeast sides are upgraded to widen the northern and southern access ramps, (3) traffic is being deleveled in the east-west direction by building an underpass at level -1, (4) on the site of the western overpass an embankment and a green plateau are being built between the western ramps above the underpass, (5) a new overpass "East" with larger span is being built, (6) the pedestrian underpass under Remetinečka cesta is being upgraded on the west side, while the pedestrian underpass on Dubrovnik Avenue is maintained in the existing dimensions, (7) the tram tracks in the scope of intervention are reconstructed and a tram turnaround is built within the roundabout, (8) noise protection walls are being built on the south-east side, next to the Savski Gaj settlement, and (9) existing installations are being relocated to prepare for the passage of future installations (protective pipes in the road body for the future hot water pipeline). Based on the requirements from the special conditions of construction and additional requirements of public bodies, and the requirements of authorized auditors during the preparation of main designs, concerning the solutions in the preliminary design, the solution was adjusted [2].

2 Features of the main and detailed design

With the elaboration of the Preliminary Design on a more detailed geodetic survey and further elaboration, the traffic areas on Dubrovnik Avenue were additionally corrected in terms of layout and height, so that the pedestrian underpass Savski Gaj could be kept in the existing dimensions. Bus stops on Dubrovnik Avenue have been further extended. The relocation of the existing water supply pipeline along the northwest ramp is planned, due to the requirements of VIO Zagreb. The locations of the noise protection walls have been corrected concerning the existing car entrances. Additionally, fire hydrants were designed at the entrance-exit of the underpass with hydrant supply pipelines with connections to the existing city water supply network. During the construction, new problems appeared that were not included in the preliminary or main project. Due to the above, an amendment to the location permit, and the amendment to the construction permit were obtained. The elements of the modified design solutions are described below.

2.1 Construction pit protection

In the process of project development, and given the circumstances at the site, variant solutions for the protection of the construction pit of the underpass with retaining walls were made, to select the optimal final solution for the protection of the construction pit and the underpass. A wide excavation for the protection of the construction pit with a diaphragm was carried out from elevation 117 m above sea level on the access ramps in the east and west to elevation 113 m above sea level in the central part of the roundabout. The excavation depth within the diaphragm area was up to a depth of 8.5 m, and in the area of the pumping station up to 11.33 m. Considering the need to protect underpass structure during exploitation from buoyancy forces, depth of excavation, and groundwater at the height of 112 m above sea level, the protection of the construction pit was designed with two anchored reinforced concrete diaphragms (south and north) and two clay concrete diaphragms (east and west). The construction of the diaphragm and the underpass are separate, for simpler construction and better waterproofing. The construction of the diaphragm was also the formwork for the outer walls of the underpass. The diaphragm is designed to be waterproof. To accept any leachate, the diaphragm is lined with insulating-drainage tape, and circumferential drainage ribs are made by which water is channeled into the central collecting drainage pipe which is fed into the pumping station, where it is evacuated utilizing automatic pumps. Maintaining the water level below the foundation level protects the construction.

Figure 1 The diaphragm works for the protection of the construction pit (left) and peripheral drainage ribs (right)

2.2 Underpass design

Two underpasses have been designed, one for each road. In that part, the roads are separated due to the fit into the wider dividing zone on Dubrovnik Avenue, where the tram line is located. The underpass consists of three parts: closed frame constructions of the underpass itself under the embankment of the roundabout or under the ramps (black in Fig. 2), open troughs in front and behind the underpass (magenta in Fig. 2) which end below with classic retaining walls (yellow in Fig. 2) ascending towards the level of the surrounding terrain. The closed frame reinforced concrete structure has a wall thickness of 1.0 m, a wall height of 6.8 meters, and the width of the underpass is 12.5 m.

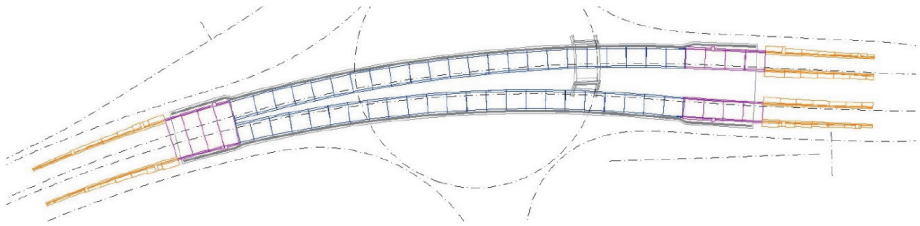

Figure 2 Underpass position with access ramps

2.3 Rainwater drainage pumping station

The pumping station is located between the north and south underpasses. It is designed as a reinforced concrete underground facility with a pumping pool and pumps (3 + 1 spare), the capacity of each pump Q = 140 l / s, and the height of the water lift H = 11.7 m. The bottom of the pumping basin is at an altitude of 102.52 m above sea level. The upper "floor" at an elevation of 107.72 m above sea level, is intended as a latching chamber for the accommodation of pressure pipelines (fittings and plumbing fittings), electrical cabinets for the accommodation of electrical installation of the pumping station, openings for assembly and disassembly of pumps, and openings for the descent into the pump swimming pool. Backup power supply energy is provided by a 250 kVA Diesel-electric generator (DEA). An external unit, soundproof - 68 dB / 7 m, with a large tank in the base of the unit -1,200 l, which provides sufficient autonomy in the event of a power outage. The main project envisages access to the pumping station from the underpass. To enable the descent to the upper floor of the pumping station without entering the underpass (requirement VIO dd at the time of construction), a "service entrance" was made on the cover plate of the pumping station to enter the pumping station from the central part of the rotor.

Figure 3 A phase of derived diaphragms and underpass (left) and derived diaphragms, underpass, and temporary road for traffic regulation (right)

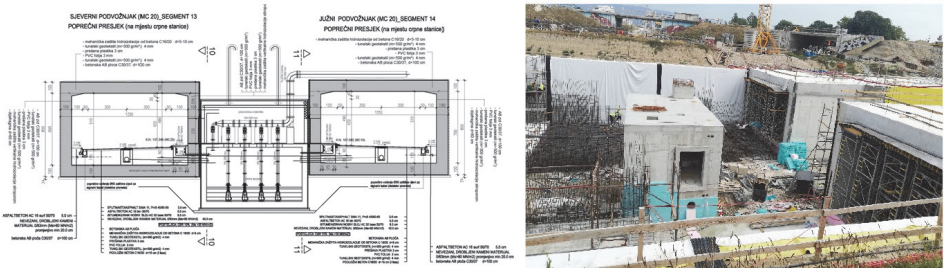

Figure 4 Position of the pumping station between the two underpasses

2.4 Overpass reconstruction

The preliminary design envisages the upgrade of the existing overpasses on the outside of the roundabout. The span assemblies of the existing constructions are made of SAN supports 70 cm high. There is no concrete pavement slab above the girder. The girders are connected into one unit by transverse prestressing. Such a solution is no longer applied today because it has proven to be poor in terms of durability. This system is difficult to upgrade, so the existing girders were removed and new 50 cm high SAN girders were installed on the overpasses, above which a 22 cm thick reinforced concrete pavement slab was constructed, and the lower structure was upgraded due to expansion.

The existing East overpass was demolished to build an underpass. The span of the new overpass East is 23.4 m (existing span 12 m) and is conditioned by the free profile of the tram line and the position of the underpass (the foundations of the new overpass are moved away from the underpass walls). Its construction posed a challenge in the dynamics of the works. Due to the size of the span, the required free profile for the tram line, and the retention of the level of the roundabout itself, the overpass could not be made of prefabricated elements. The start of work was at the same time conditioned by the completion of work on the underpasses.

At the site of the West overpass, an embankment is planned to be built over the underpass on the inner side of the roundabout, while a “green area” is planned on the western side over the underpass. The North and South overpasses were not the subjects of the Preliminary Design. The North overpass, above the tram line, has been repaired. Since there is no traffic under the South overpass, it was removed and an embankment was built in its place.

2.5 Noise protection

The locations of the walls for noise protection and the type of panels were corrected concerning the proposals from the preliminary design, and according to the Study of noise protection which was done in the phase of the main project. Noise protection was performed along the ramp Remetinečka-avenue Dubrovnik and on the part of the avenue Dubrovnik itself.

2.6 Installations

The biggest challenge in the design - and later in the planning of works and execution, was an extremely complex "installation node" in the area of the project, which had to be harmonized with all facilities and traffic areas as well as traffic equipment and signalization.
The project envisaged protection and relocation of all types of installations outside the underpass construction route with the construction of new parts of installations (sewage collector, water supply, drainage with the construction of underpass pumping station, electrical installations, TK and DTK installations, gas installations, public lighting...), as well as execution traffic equipment and accompanying installations (protective fences, traffic light cable channels, traffic information system, load-bearing structures - portal girders), and relocation of the existing and construction of a new tram cable and contact network. Before the works on the reconstruction of the intersection, it was necessary to relocate the installations in the excavation zone for the diaphragm and underpasses.
HEP-TOPLINARSTVO doo plans to lay a hot water pipeline in the project area. During the reconstruction of the intersection, preparations were made for laying pipes under Dubrovnik Avenue, through which hot water pipes will be laid/retracted later (during the construction phase of the hot water pipeline).

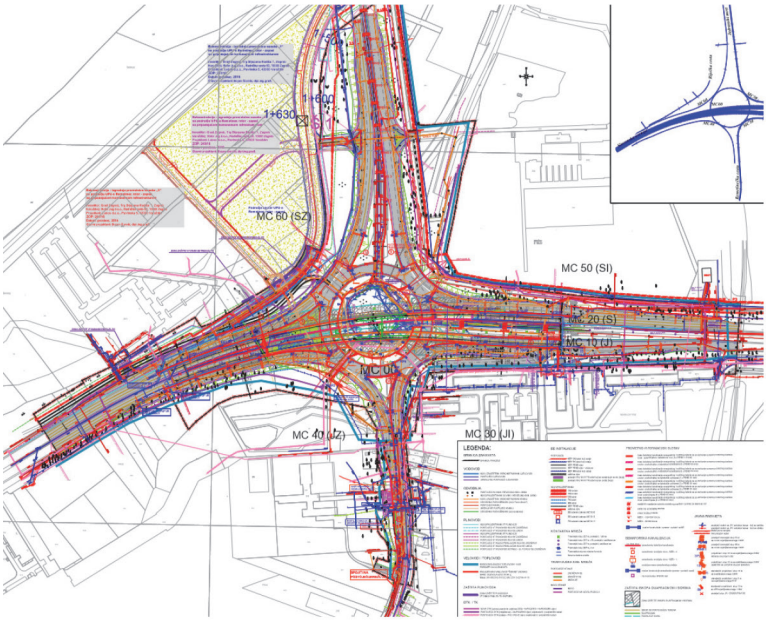

Figure 5 Illustrative view of the "installation node" in the area of works at the intersection

Figure 6 Leaking pipes for the hot water pipeline on Remetinečka cesta

2.7 Tram tracks

The tram track was repaired on the section in 2011, so the minimum length of the track was reconstructed as needed to fit into the new roundabout solutions. Within the roundabout, the project envisages a tram turnaround, with the additional possibility of a direct turn of the tram from the direction of the Adriatic Bridge towards Dubrovnik Avenue.

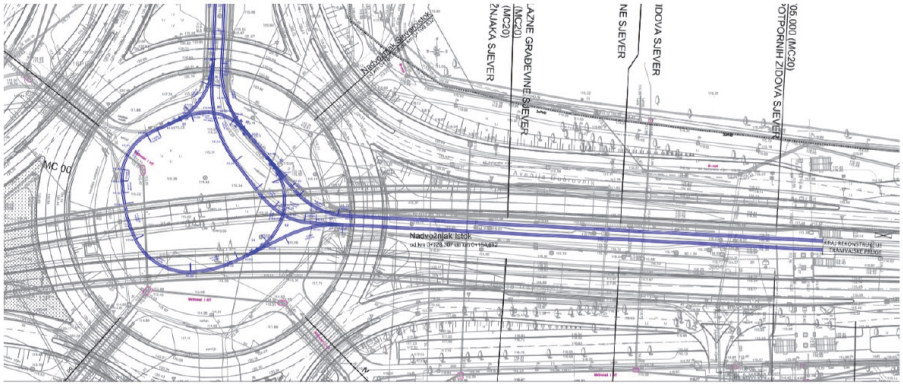

Figure 7 Presentation of a new tram line solution in the roundabout itself

3 Temporary traffic regulation

A special challenge was to find the optimal solution for the temporary regulation of traffic during the execution of works so that traffic and works take place with minimal restrictions, which would contribute to the execution of works within the defined deadlines. The preliminary design envisages the flow of traffic in the roundabout during the reconstruction works. Such a solution would significantly affect traffic flows, dynamics, and quality of work. An additional reason to think about relocating traffic outside the construction site zone was the fact that 17 lines of public city transport operate through the roundabout. Frequent changes in lines and timetables would cause additional problems in the organization of public city transport.

Since the conditions and manner of reconstruction (replacement of complete overpass supports) and the conditions for relocation of existing installations have changed, staged construction and traffic in the reconstruction zone was not possible and was replaced by a proposal to build temporary roads that completely relocate traffic outside the construction

zone. In this way, the safe flow of traffic is ensured and the number of changes and necessary adjustments to the schedule of public city traffic is minimized, while at the same time the closure of the entire construction site is enabled, and thus unhindered and faster execution of works.

In the selected final solution of the temporary road, vehicles with a height of› 3.5 m (conditioned by the passage of the route under the existing HŽ overpasses on Dubrovnik Avenue) and out-of-town bus lines are excluded from traffic. Pedestrian and bicycle traffic was reduced to one traffic light crossing on Dubrovnik Avenue at the end of the project near Mate Parlova Street. With the closure of Kajzerica in the works zone, the traffic load and the possibility of congestion within the city district have been reduced. Mate Parlova Street from Dubrovačka Avenue to the school in M. Parlova Street was left as a pedestrian and bicycle corridor.

The challenge for the design was the development of a completely new road project through which 70-100 thousand vehicles will pass daily, within two months, and obtaining a building permit for that project. Traffic on the roundabout was closed gradually. First, tram traffic was suspended, to enable preparatory work on the relocation of installations, the start of work on the protection of the construction pit, and the construction of a temporary road. Only after the completion of the temporary road was the roundabout for motor vehicles closed. This organization of traffic and reconstruction works enabled the safe conduct of traffic and reconstruction works, as well as the achievement of agreed construction deadlines.

Figure 8 Presentation of the solution of temporary traffic management during the works

During the reconstruction works, occasional traffic counts were carried out at the control sections. Initially, 75,000-80,000 vehicles passed through the temporary roads daily; which was only 17–20 % less than the regular traffic before the reconstruction began. Eventually, traffic on temporary roads became higher than it was on the roundabout before work began. ZET's public city traffic took place regularly, on almost all lines as in regular condition and there were no delays caused by the works.

Figure 9 Temporary traffic management during the works

4 Concluding remarks

Since the announcement of the tender for the Contractor in November 2016, the signing of the Contract in May 2018, the preparation of the project of temporary roads, and the introduction of the Contractor in July 2018, despite many described challenges, planned deadlines - 09.01.2020. the first phase and 30.03.2020. the second phase of works - are complied with. During the project, a building permit was obtained for temporary roads and a new building permit for the entire project, which dealt with changes in the project and the construction phase. The contractual construction period of 18 months was adjusted to the selected phase of reconstruction of traffic areas in such a way that in the first phase traffic was released over the constructed roundabout so that temporary roads could be removed, which was a prerequisite for the completion of the tram, pedestrian areas and final horticultural landscaping.

Figure 10 Overview of the reconstruction of the intersection of Jadranska Avenue and Dubrovnik Avenue (visualization)

References

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