

THE NEW TRAM LINE DESIGN IN THE URBAN AREA OF BRATISLAVA

Dr. T. Schlosser, Bc. E. Pomichal, Dipl. Ing. G. Balint

^{1, 2, 3}Department of Transportation Engineering

Faculty of Civil Engineering, STU in Bratislava, Slovakia

¹tibor.schlosser@stuba.sk, ²e.pomichal@gmail.com, ³gabo.balint@gmail.com

ABSTRACT:

- Development and modernization of the Capital of the Slovak Republic Bratislava has started a new large scale investments in the field of down town urbanization. On the territory of the Old City (Staré Mesto) and in part of the Eastern district - Ružinov which is located on the bank of Danube River has already begun the process of building a new central area of the city with all the major features and urban functions. The construction of this new zone of the city carries itself the necessity to deal with problems in public transport and individual car traffic.

Keywords: public transport, tramway, rail tracks, urban area.

I. INTRODUCTION:

The Master Transport Plan of City Bratislava (MTP) [1] proposed the extension of the tram network in the city. According to this plan twenty-two new routes have to be studied. Based on the results of MTP and scenarios there were recommendations to deal with feasibility studies for three of them. The subject of the article focuses on the design of the route of a planned tram line Kamenné square – Dunajská street – Mlynské nivy (Figure 1).

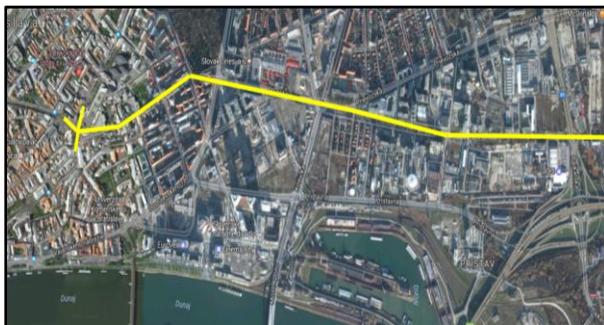


Figure 1: Scheme of the new tramway line in Bratislava

Public Transport (PT) in Bratislava consists of a bus network as well as tram and trolley lines. The built tram network is defined in Urban Master Plan (UMT) of Bratislava city as part of the Carrying PT System. Tramway transport is secured by the network rail gauge 1000 mm. The length of the double rail tracks is approximately 42 km. The vehicles have a maximum permissible traffic speed 65 km/h, but the internal regulation of the speed limit is 50 km/h only. In some places the speed limit is lower, considering the circumstances of the surrounding terrain or buildings in urban area. The lines are in radial layout. They cover the city centre, the eastern, western and southern parts of the city. On Figure 2 there is a diagram of the network of tram lines.



Figure 2: Diagram of the tram network of Bratislava, source: www.imhd.sk

II. THE TRAM TRIANGLE OF THE KAMENNÉ SQUARE – SETTING THE NEW TRAM LINE

The key problem of the tram track technical feasibility over the Dunajská Street is to solve the rail triangle on Kamenné square. The rail track triangle on Kamenné square will connect to the planned tram track on Dunajská street from two directions. Currently, the track triangle enables to cross the tram dual-track on Štúrova street, Špitálska street and on

the Square SNP. On Štúrová street there is a double gauge track to Jesenského Street where there is also a triangle but the dual track ends in front of it.



Figure 3: Dual track on Štúrova Street

The double gauge consists of a 1000 mm gauge used by trams as well as a 1435 mm railway gauge to a planned tram-train. The construction of the tram track to Dunajská street will require a rebuilding of both triangles in Jesenského Street as well as in the Kamenné square. The rebuilding of the rail track triangle in Kamenné square allows to link it with the tram track from two directions: from square SNP toward Dunajská street and from Štúrova street toward Dunajská street. The other option might be to link with a 1000 mm gauge tramway from square SNP to Dunajská street and the rail track with a 1435 mm gauge from Štúrova street to Dunajská street. In Dunajská street would be a double gauge 1000 mm and 1435 mm. During the reconstruction it is suggested to use the turnout with contraflexive curve, simple turnout or diverging points. From square SNP to Dunajská street is proposed to use double contraflexive turnout from the opposite direction as well. The speed limit on the diversion tracks are 15 km/h. The minimum radius is 27 m which one is exceptionally allowed in our standards for 22 m. This is in the cramped conditions covered, and it will be used for the 25 m curve of Štúrova street toward Dunajská street. Figure 3 shows the scheme of the proposed wiring design on the Dunajská street although other technical solutions are also possible.

The proposed solution is logical and technically feasible not only in terms of servicing the town centre but also the individual radial connections of the entire city.

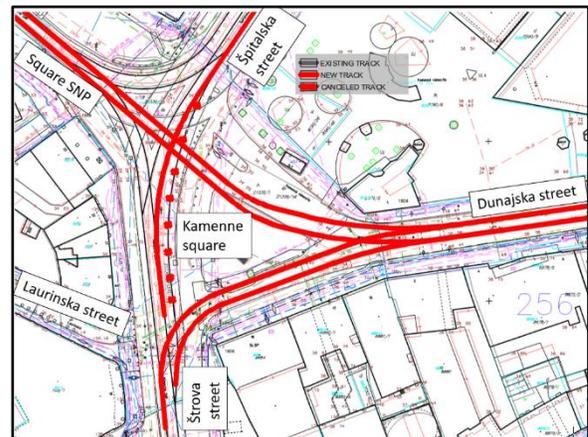


Figure 4: Scheme of the remodelled tram triangle on Kamenné square

III. THE LINE KAMENNÉ SQUARE- DUNAJSKÁ STREET AND A PROPOSAL FOR THE TRAFFIC ORGANIZATION

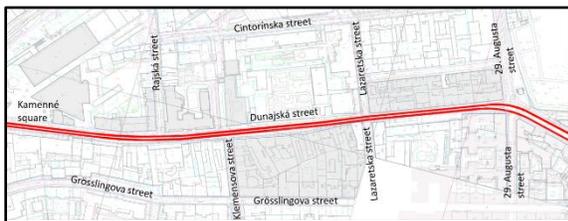
The proposal for a new rail track takes into consideration the already established network. Generally, the intention of proposing a new design route is considering the rules of horizontal segregation with maximum radius or in a straight line, if the surrounding conditions as the existing road network, terrain and buildings allow it. According to the transport model of MTP [1] for Bratislava the new line Kamenné square - Mlynské nivy – Prievoz is going to be as follows (Figure 5):

- as a tramway one direction through Dunajská street to the Centre and the opposite direction from Grösslingova street through the Centre up to Mlynské nivy,
- from Mlynské nivy it continues until the intersection with Košická street,
- after Košická street it continues through the park area to Plynárska street junction up to the crossing with Bajkalská street.



Figure 5: Recommendation of the tram line from MPT [1]

In our design solution, we have excluded the possibility of keeping track through the Grösslingova Street (see Figure 6). Its reason was not only the negative public opinion but also the possible complications that can occur when the tram track is connected to an existing network at Štúrova street. In this proposal we are thinking on the construction of double track railway via the Dunajská Street. Since the width-only arrangement and transport space to the street is not sufficient for car traffic and tram transport, we propose the exclusion of car traffic from Dunajská Street. Then we create a pedestrian zone with public transport, and with the approach of the target traffic just like in the operation of the Obchodná Street, where Bratislava has more than 30



years such a pedestrian zone. Transverse links of this territory, however, will be remaining for the passage of the car traffic.

Figure 6: Scheme of the tram line via Dunajská Street

The section begins at the Kamenné square with the establishment of another new "triangle" in the direction to the Dunajská street trough Kamenné square up to Šturová street. There will be three jointed crosses to the tram transportation: the Kamenné IV. THE ROUTE ON MLYNSKÉ NYVY CLOSE TO NEW

square itself, a new one on Dunajská street and one on Jesenského-Štúrova Street. The strategy of an appropriate solution is based on the layout of the tracks with turnouts on the routing of the already existing and the new lines to the radials of Dunajská Street – Mlynské nivy. The scheme of the lead tracks and turnouts is shown in Figure 6.

A separate issue is the review of further development of tram traffic by blocking the normal gauge (1435 mm) track which offers to the city of Bratislava a comfortable and integrated development for many decades even in the downtown areas. There are already existing initiations for more-line track which is already built upward the southern part of Bratislava, in Petržalka.

At the crossing of Dunajská street with the one-way Rajská street it is considered the trolley bus line 205 and 202. For this reason, the electric network needs to be realized to fulfil the needs both the trams and the trolleybuses. There will not be possible to access the Dunajská street from Klemensova Street, there will be only origin/destination traffic towards the parking lot at the high school and into the underground car park under Dunajská street.

In the junction of Lazaretská street and Dunajská Street the turn from Lazaretská Street to Dunajská will be prohibited. On Lazaretská Street the two-sided parking spaces will be terminated which results the connection between Cintorínská and Grösslingová streets by two-way car traffic. The details are on the Figure.

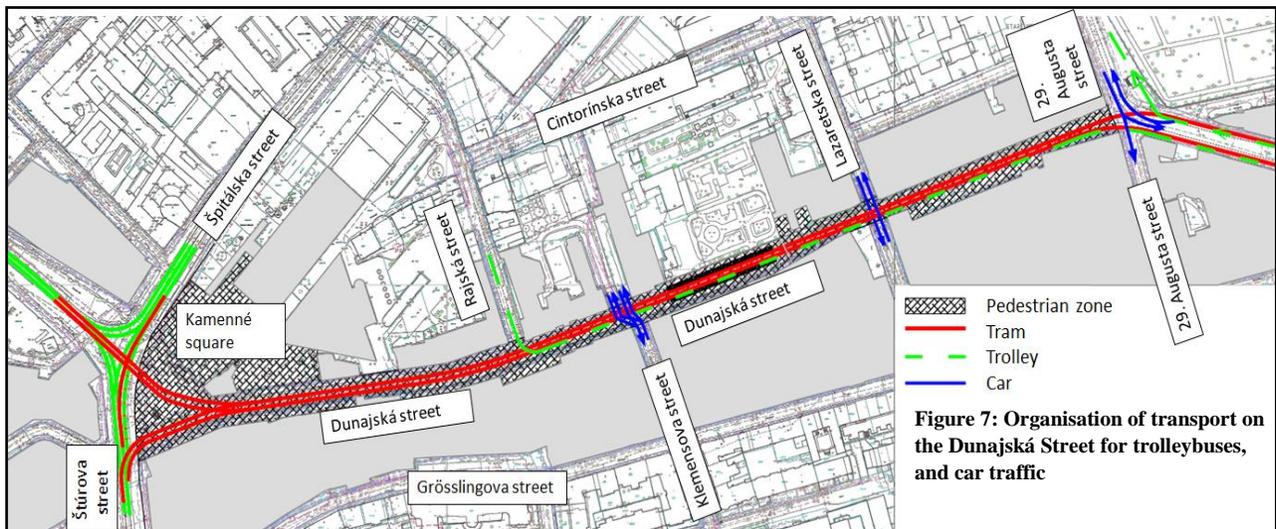


Figure 7: Organisation of transport on the Dunajská Street for trolleybuses, and car traffic

CENTRE TWIN CITY

From the junction Dunajská Street – 29. Augusta Street – Mlynské nivy the tram where the tracks located in middle of the road is divided onto the sides of the urban street. Thereby the tram and trolley bus traffic will be moved to outside lanes as one-way line and these lines will be allowed to use only for public transport. From this junction, the tram traffic will be lead together with the rest of the traffic in lines reserved for public transport (as shown on Figure 8). The pedestrian zone ends at the end of Dunajská street.



Figure 8: Extension of tram track on sides of the street Mlynské nivy

Another important junction with traffic light in the project is the crossing of Karadžičová Street with Mlynské nivy. The tram line continues down the street in a similar arrangement from the 29. August Street, i.e. on the two sides of the road. At the same time the tracks will be a horizontally segregated lane for public transport. It is important to consider the ongoing and planned constructions, such as: the new bus station on Mlynské nivy [3.]. In the new downtown zone the Twin City "A" and "C" projects are already realized. The other projects are expected to carry out by 2019 according to the plans. A new tram line is planned on the Karadžicova Street [5.] as well which will result another important junction. The optimization is very important due to the ongoing construction of the Twin City tower as well as the new location of the bus station.

At the other end of the Twin City development there is located a traffic lights controlled junction: Mlynské nivy – Svätoplukova – Košická (Figure 8). The shape of the junction raises the problem of capacity and the optimization of the traffic lights programming. The junction is already saturated but a tramway line has to fit here as well. From this junction, the main tram line is not to continue through Prievozská street but on Mlynské nivy Street. We propose that this line should lead in the middle after crossing Súkennická Street behind Košická street where there are currently parking lots or green belt area. It is necessary to solve crossing for new tram

line in Prievozská - Mlynské nivy crossing in direction to centre through Prievozská street (Figure 9 - right). This has to be solved by putting the tram lines on the two sides of the road together with another kind of PT – bus and trolleybus. These changes of the traffic organisation will be done and controlled by traffic lights. Tramway sensors which detect the presence of the tram (via GPS coordinate of moving tramway) could ensure the dynamic traffic control preferring the tram traffic to the city centre.

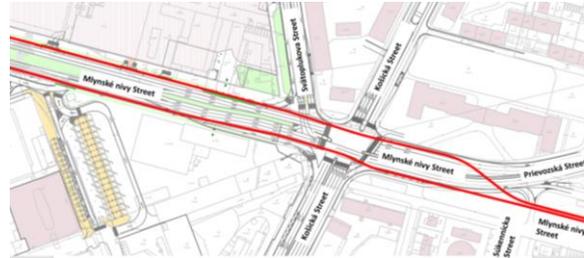


Figure 9: Line leading on the sides of Mlynské nivy and connection from Súkennická Street to Prievozská Street.

V. THE ADMINISTRATIVE CENTRE APOLLO AND MLYNSKÉ NIVY-WEST

There is a consideration to build up an urban boulevard in Mlynské nivy up to crossroad with Bajkalská Street. The boulevards are playing a significant role in city urbanism. They are wide streets with green belt area, traffic lines, sidewalks or pedestrian zone. The boulevards are characteristic from direct or curved nature of lines to direct the urban communication. Often they are with function as inner ring roads.

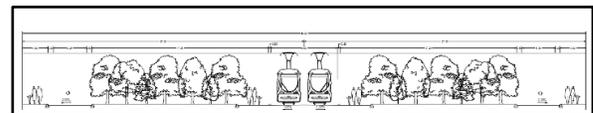


Figure 10: The cross-section of the Boulevard at Mlynské nivy

The boulevard at Mlynské nivy should be a pedestrian zone, where in the middle of it with two-line tramway track and with one-way lines for traffic on sides of it. There is a possibility to place the individual car traffic in level of underground with parking which is necessary to build along of whole width of the boulevard area. The parking traffic in former times was not an aspect during urban design at all, so it is a “must” to solve this issue on Mlynské nivy from Košická Street up to Bajkalská Street. The fault of static traffic may result degradation of this area from social and territorial point of view as well. Therefore, is inevitable to find such engineering solu-

tion for whole parterre which will be the carrier system of this boulevard. The drainage system and to find appropriate greens for pedestrian zone are need to by solve.

It is recommended to change the junction with Plynárenská street which is now as a simple roundabout. (Figure 11) Due to new tram line and planned redirection of road traffic to underground is necessary to think over suitability of traffic roundabout. If we consider its implementation it would be a solution to install traffic lights because of crossing the junction by the tramway. From junction Plynárenská to junction Bajkalská the tramway track should be led parallel with communication in green belt area.

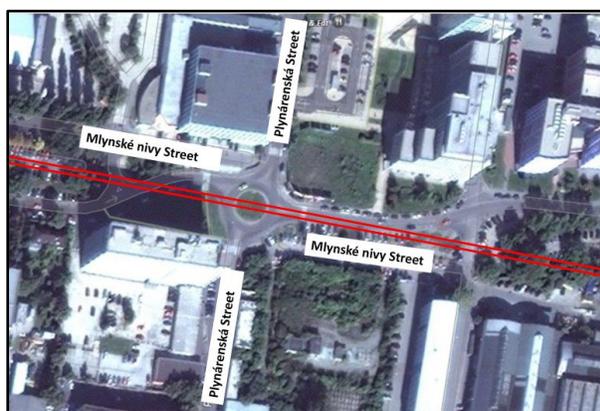


Figure 11: Scheme of the tram line on Mlynské nivy Street

Bajkalská street has a realized underpass in straight direction where is is an existing concrete bridge structure which is currently covered in. After this undercrossing the tram line is continuing still via Mlynské nivy and it is suggested to lead this line up to future development area of Domové role in Ružinov with the possibility to continue up to refinery Slovnaft and Podunajské Biskupice borough. At the end of Mlynské nivy is recommended to end the tramway line without turn bay similarly as it is ending of tramway line with two-rail turnout in Petržalka borough.

VI. CONCLUSION

New construction in area of Mlynské nivy evokes urgent need to build up a capacity system of public transport in this area. The MTP of the city has recognized that the integration of tramway line in this area from Kamenné square – Dunajská street - Mlynské nivy is reasoned.

The building of new downtown of Bratislava raises high requirements for the public transport. This result the modifications in case of carrying PT system as well. Realization of mentioned tramway line in this city area should be reduce the load of other form of public transport and should contribute to higher comfort and increase the PT capacity in the city. By optimization and supplementation of timetables with other public transport kind it is possible to create a good quality system which could be competing with individual car transport. According special traffic surveys there are less than 2 people using a car which results a need for high capacity park houses next to workspaces and shops. According to preliminary calculations is necessary to count with about 20 000 car parking places in area of new city centre which is confirming the traffic collapse in defined quadrangle Mlynské nivy – Košická – Landererova – Karadžičova.

The planned new administrative-residential-leisure zone in centre of Bratislava will be significantly changing the services of this area and its traffic volume. Our study clearly shows that these changes predefine completely the whole current traffic relations and will be establish a higher quality of service for this new area of interest by city rail-track transport with adequate capacity. It is necessary to solve accessibility of public transfer's input/output access points.

Following traffic-engineering, traffic-urban and traffic-planning steps have to be carried out which are the main attributes of the new tram line's solution in details:

- to confirm the main strategic direction of the tramway lines in the entire area by a technical solution and to concern the traffic capacity with the assessment of dynamic car traffic flows but reconsider the transformation modal split toward public transport at the same time,
- to make a comprehensive transport survey of the entire area of the new downtown, whose realization has already started [2] and from it competently to define disproportion of area's current service,
- to create a functional traffic model based on the model of MTP with the possibility of making several scenarios for handling the variability of the area in terms of the creation of new stops of public transport for all the PT kinds operating in Bratislava,

- To reconsider all controlled junctions by traffic lights of this line by scenarios for several time gaps in years with proposals to modify the junctions on this area. In case of collapse of current traffic organization system to solve their modifications with proposal of new types of junctions from large roundabouts by tram line to interchanges in different levels for main traffic flows,
- to resolve the basic relations of pedestrian flows and its routings with sufficient capacity in urban traffic patterns, it means from design of pedestrian zone in Dunajská street up to boulevard in Mlynské nivy,
- To solve completely the modal split in the whole area of the new downtown, mainly cycling infrastructure with main public traffic stops connections outside of main traffic streams which are followed by a high dynamic traffic volume.

ACKNOWLEDGEMENTS

Paper was created with the support of the projects VEGA 1/0501/17 environmentally acceptable materials and technologies for traffic areas and ITMS: 26240220084 - University Science park Slovak University of Technology in Bratislava

REFERENCES

- [1] Kolektív: Územný generel dopravy hl. mesta SR Bratislavy (Transport Master Plan of Bratislava), CDV Brno, 2015
- [2] Schlosser T., Schlosser, P. a kol.: Súčasný stav obsluhy územia nového centra mesta v oblasti "Chalupkova" (present situation of traffic organization of new city centre in area of Chalupkova), DOTIS Consult, 2017
- [3] Schlosser T., Schlosser, P. a kol.: Dopravno-inžinierska štúdia atraktívnosti prímestskej verejnej autobusovej dopravy v aglomerácii Bratislavy, (A Transportation Engineering Study of the Attractiveness of the Suburban Public Bus Service in the Bratislava Agglomeration), DOTIS Consult, 2016
- [4] Talaš R., Klaučo E.: Mlynské nivy – západ, Bratislava – Urbanistická štúdia zóny – (Urban study of Mlynske Nivy West zone), SIEBERT+TALAŠ, s. r. o., 2009

- [5] Borš M.: Návrh trasy mestskej komunikácie s električkovou traťou nám. L. Štúra – Pribinova – Karadžičova v zastavanom území Bratislavy, (The design of urban street with tramway track) STU Bratislava, 2017
- [6] Siebert M. a kol.: Urbanistická štúdia Kamenné námestie, (Urban Study Kamenne Square) SIEBERT+TALAŠ, s. r. o., 2013

BIOGRAPHIES



T. Schlosser, PhD, degree in civil engineering, from the Slovak University of Technology Bratislava, Slovakia, in 1981. Currently Head of the Transportation Engineering Department, Faculty of Civil Engineering, STU Bratislava. His professional activities are oriented on Traffic planning and engineering, Intelligent transport systems. He was a former Chief Traffic Engineer of the Capital City of Slovakia – Bratislava



G. Bálint, degree in civil engineering, from the Slovak University of Technology Bratislava, Slovakia, in 1998. External PhD student and assistant of the Department of Transportation Engineering, Faculty of Civil Engineering, STU Bratislava. His professional activities are oriented on railroads and roads. He is a transport designer.



E. Pomichal, graduated on the Secondary School of Building Constructions and Geodesy, department Technical and Information Services. She received BSc. degree in Slovak University of Technology in Industrial and Road Constructions Department. Currently she is doing master studies at Department of Transportation Engineering.