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Development of Public Rail Track Transport in Nord-Western Area of Bratislava

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Abstract. The article deals with the development plans and possibilities of the Bratislava north-west expansion direction. Its focus is on the sites in the Lamačská Brána area – Bory and CENTROP – which with their size of approximately 817 hectares are owned by two major developers. The article describes variants of possible rail transport system extension, as it is classified as the cordial system of public transport by the Bratislava urban planning documentation. The traffic service proposal deals with the new traffic infrastructure on given future and realised locations and generates input for the traffic planning itself, which will define the build intensity restriction using the traffic model. Particular variants of the rail transport in given area are proposed to be the primary tool for future area development possibility. Along with the urban tram with narrow gauge of 1000 mm defined in urban planning documentation, the area service is considered by the introduced standard gauge (1435 mm) tram-train track connected to the international railway link. This track is intended to be a part of the integrated suburban public transport system aiming to access the satellite town Stupava inside the Bratislava city agglomeration.

1. Introduction

Every city's development is subjected to the urban planning documentation. Bratislava was not able to direct its own development over the period of last decade. Such undirected expansion caused unrestrained build-out without a vision, without continual traffic service solution in relation with the region within the agglomeration. Today the problem of every new investment is, that the investor wants to multiply the value of his real estate with minimal expenses, regardless new people – city residents – once living, working or spending their time in his investment. Furthermore each new investment affects the existing urban area, where other people live for even decades and they think of their environment very conservatively. The city should stand on the inhabitants side and direct the development so that it would be pleasant for the people to remain, eventually to constantly return for work, services and amusement, because the city is worth living in.

The city position in this issue must consist of systematic regulation of build-out in order to reach contemporary modern conception of forming so called „smart cities" – sustainable living and sustainable mobility. Each new investment, large or small, should have the people's mobility system solved. Illogical delocalisation of the employment, services and free time functions beyond the residential area causes huge transportation demand, especially for the personal car usage. The first level of solution is correct saturation of various functions in given area. The second level is traffic

planning as a whole, not just to design the connection of an object to the road system, but to integrate the site into the supply – demand system of region, for the area to „breath“ and sustainably develop.
The article creation is tied with the intention to develop the Bratislava city north-west expansion direction, areas in the location Lamačská Brána – Bory and CENTROP. The intention is to create an extensive build-out of services, free time, residences and industry producing new traffic supply and demand. It is necessary for us to know the area in order to create the area serviceability proposal; therefore this article deals with the current state analysis with introduction of strategic solution of area service by rail track public transport system. Rail transport is the basic attribute of integration of traffic system for sustainable improvement of mobility itself and of the urban life quality.

2. Area analysis

The given area is located in the southern part of Záhorie lowland between the massif of Devínska Kobyla and slopes of Lesser Carpathians. It lies within the city limits of Bratislava the capital of Slovak republic (see Figure 1). The area is divided into cadastral communities of the boroughs of Záhorská Bystrica, Devínska Nová Ves and Lamač. The northern edge of the area is bordering the cadastral community Mást I. which is part of commuter town Stupava. The air line distance between area‘s southern edge and the city centre is approximately 9 km. Western outline of the area is in the narrowest spot 3 km away from the border with Austria. The town Stupava lies 3,5 km to the north from the treated area and the town Malacky, as the tertiary regional centre, 21 km to the north. Area is delimited from the south by the road II/505 and parallel railway ŽSR 110, connecting Bratislava with Vienna and Brno, by the road II/505 along with Volkswagen car factory employing approximately 12 500 people from the east. The western edge consist of the motorway D2 connecting Bratislava with Brno and Prague and the northern limit is the D4 motorway, the future „zero bypass“ of Bratislava, today build in length of approximately 3 km in half arrangement (one roadway).

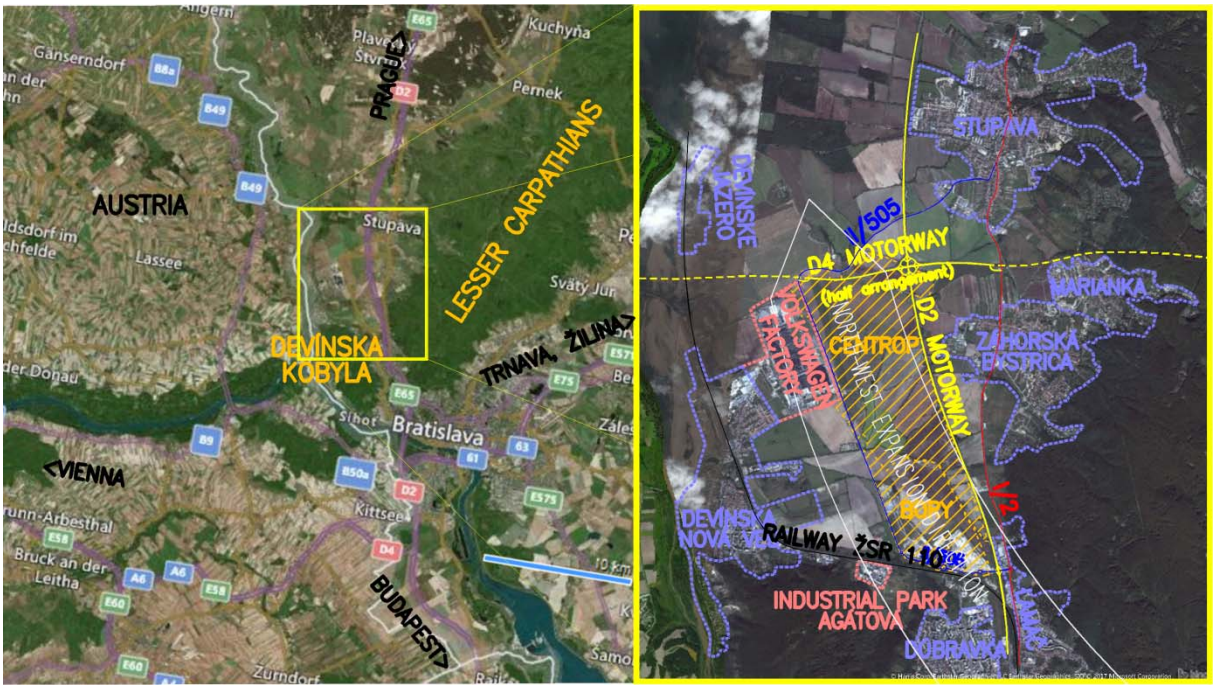

Figure 1 – Location of the analysed area

Given area is composed of two main parts – Bory and CENTROP. Bory with the area approximately 245 hectares represents the southern section between the road II/505 and Lamač creek. CENTROP is located in the northern part from Lamač creek to the D4 motorway. Its area within the delimited area is approximately 570 hectares. In the area there are smaller watercourses – the Morava river tributaries – which form the biocorridors. There is one biocentre – Kamenáče – it is located in the southern part

of CENTROP [2.] and its area is approximately 44,5 hectares. In the process of land aggregations, that take place in the CENTROP, the solution for basic communication system was required to secure the area development. The plots of land reserved for the road system in the area are based on the urban planning study by American urban planner Guy Perry.

3. Urban planning documentation

In accordance to the valid urban planning documentation (UPD) the Bory area is meant for the build of services, offices and retail (UPD code 201 – 165,6 ha) and mixed land use of services and residential zones (UPD code 501 – 41,0 ha). The northern part – CENTROP – is according to the UPD classified as agricultural land yet. The developer of Bory already started with the urbanisation. The shopping centre Bory Mall and a part of the commercial zone Bory Retail [3.] holding up to 20 large capacity business operations were built there . The zone Bory Home where 10 blocks of flats should be built in the first phase, later a whole quarter, is in the preparation process. The developer plans are to create an area of mixed services and residential function, making it the centre with municipal and regional importance. The developer of CENTROP does not have clearly delimited spatial structure or the land-use because of the area is missing the urban classification as a development zone. In previous stages an urban study for CENTROP was created combining the residential, services and industrial land-use. Later the developer planned to create a single family residential zone. Today the company owning most of this area pushes the city to change the UPD in order to process the project of industrial park (zones C9 and C10 – see Figure 2) supplying the Volkswagen factory. The area will be prepared for development once the land aggregation process is finished and the UPD is changed (eventually the new UPD is valid, whose preparation has been announced) [4].

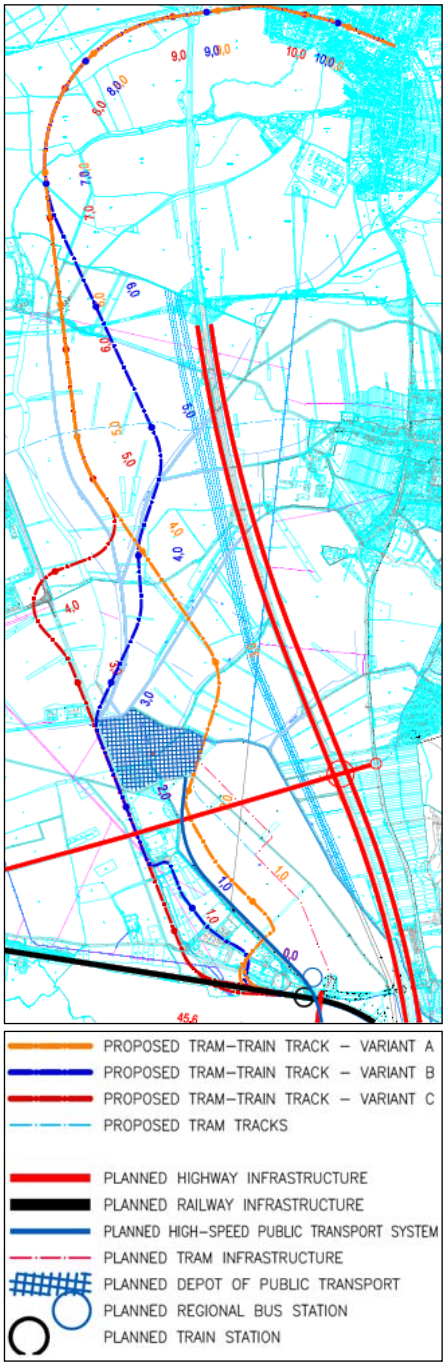

Figure 2 – The complex Road – Rail infrastructure in planned area BORY - CENTROP

4. Existing and planned build-out

In the southern part – Bory – the developer already finished some of the build-out. The condition for further expansion was the establishment of communication system servicing Bory Mall and Bory Retail zone. The road II/505 was expanded to four-lane road. Twelve roundabouts were constructed in the area, four of them as intersections on the road II/505. In the following stage the diamond shaped D2 motorway interchange „Lamač“ along with the intersection of road II/505 and Hodonínska street (first class road I/2) were reconstructed and the intersection was modified to turbo-roundabout. In the northern border of the area the section of D4 motorway was built in half arrangement (one roadway) along with the full interchange with D2 motorway *“Stupava – Juh”*. Further planned transport constructions, which will significantly influence the behaviour of the area, are listed below (Figure 2):

- extension of Eisnerova street,

- extension of Saratovská street,
- collectors along the D2 motorway and related junctions Pri Kríži, Lamačská Brána, Eisnerova,
- construction of the Integrated Personal Transportation Terminal (TIOP) Lamačská Brána on the railway ŽSR 110,
- construction of the third track on the international railway ŽSR 110,
- extension of the urban tram from Dúbravka to the area of Lamačská Brána,
- construction of the urban tram to Devínska Nová Ves,
- construction of the cordial public transport system, according to the UPD as an underground high-speed track,
- construction of the depot for public transport and for the cordial public transport system,
- construction of the regional bus station near the TIOP Lamačská Brána.

Figure 3 – Street network proposal respecting the Bory urban study [1] and land aggregation process in CENTROP

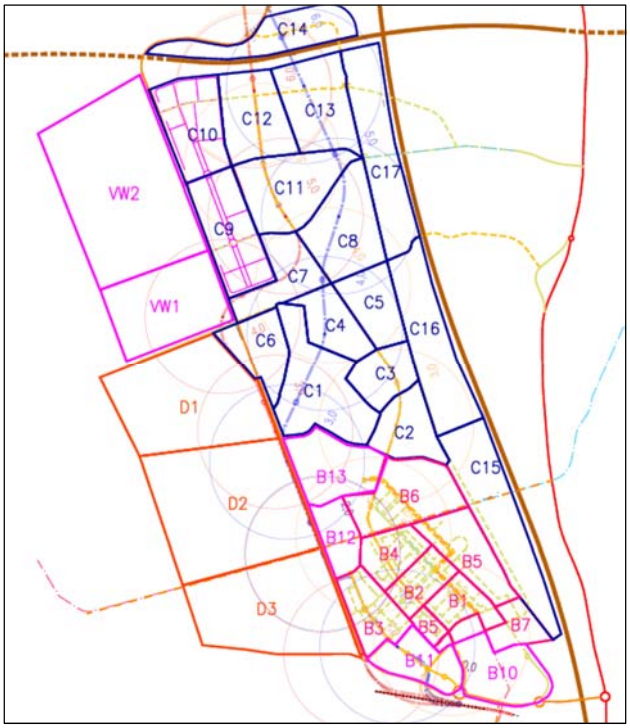

Figure 4 – The zoning proposal for traffic model in the Bory and CENTROP areas

5. The Creation of the Transport Model

The mobility is an essential requirement for the effective functioning of the urbanized area. Individual mobility, i.e. people commuting to work, to school, for services, or on a place of leisure, is an important element of personal freedom and belongs to the fundamental human rights. On the other hand, continually increasing traffic volumes is a source of environmental pressures and the loss of quality of life and, therefore, there is a necessity to look for the optimal solution to sustainable transport in relation to the quality of the environment. Mobility management is primarily a demand-oriented approach aimed at influencing the traffic patterns and behaviour of the users of transport. It is therefore important for the coordination of transport systems with the rules of modal split, as well as using the tools of the organization and the progressive traffic management. The setting of the transport model for a territory being solved, will be assessed in the light of a number of scenarios of:

- time intervals in 5 year levels with a view to + 20 years and

- alternatives of the transport infrastructure, in which case it remains invariable design of the road network (as shown in Figure 3), and scenarios will be considered keeping the rail track lines of public transport.

A clear advantage of creating the transport model is the fact that there is a sufficient range of transport surveys according the Volkswagen investment throughout the territory, carried out between 2013 and 2015, [6] and [7]. To this, there is a detailed analysis of the transport model, which in our case is used, and on its own proposal for transport – urban infrastructure. The basic decomposition of the solved area in terms of urban transport is shown in Figure 4. It can be stated that the land was detailed deeply of 35 new zones. The rural – outside transport will also be addressed in detail in the project [8], and its results are documented in [9]. From these documents, will be created a new OD (origin-destination) matrix of transport relations, which was analysed following the urban planning studies [1] and it was created a particular view of the spatial arrangement and functional use of the territory, which still does not have any supporting documentation. This solution is designed to present the idea to the system solutions for transport infrastructure, which can also give an answer to the progressive urbanization of the territory in the time frame + 20 years.

6. A proposal of an Integrated Transportation Services

As prevention against spontaneous and non-systematic city development with regard to the possibility of the territory, pointed out in this article, we recommend to work out the urban and traffic-engineering assessment of different alternatives for the development of the territory. In addition to the individual car traffic on its territory must deal with an exceptionally integrated public transport. In view of the length of the territory in excess of 5 000 m, width up to 1 600 m and the possible connection to the rail network or the network of city tramway network, in the technical proposal presents the realization of rail track linking of the new territories. To assess the effectiveness of the PT system is solved in the thesis [5], which aims to:

1. analysis of the current state of traffic service on the territory and the verification of the transport model, which was used for the development of the factory of Volkswagen,
2. alternative solution and the proposal of keeping the urban/sub-urban rail track system of the entire territory,
3. analysis of urban concepts for the future build-up area of this borough and a design proposal of zoning arrangement for the needs of the transport model,
4. the necessary steps for checking the alternatives of optimal routes – links of urban public transport,
5. assessment of the route for the carrying public transport system and determination necessary supporting documents for optimization and serviceability of future track.

The key solution is to design the guidance of the rail track routes, which are broken down into:

1. urban track – tramway line with a gauge of 1000 mm and to
2. suburb track tram-train with a normal gauge of 1435 mm, which is connected to the international railway track from Vienna and Brno in direction to the centre of Bratislava, to the Main Station.

An important expert discussion is, why both rail kinds and suburban rail, why at all? A specific solution for the tramway track is quite clear in terms of the extension of the line from Dúbravka borough to Devínska Nová Ves. This track is defined in the current generel city plan. In addition, direct allows us to expand the tram line into new territory of BORY (Fig. 5), and CENTROP, where only the normal professional estimate sets the space for urbanization for about 65 000 inhabitants and 25 000 job opportunities. This size in addition to urban areas of boroughs Lamač, Záhorská Bystrica, and the already mentioned Devínska Nová Ves creates a precedent for the new – 6th district of the city of Bratislava.

The service quality of the territory is designed to integrate the sub-urban railway, which will serve for quick connection to the city centre and to the other satellite cities in other directions. In addition, it

will allow a high value connection with satellite town of Stupava on the north side of agglomeration. This town has in recent years been developing very quickly. Currently has already 12 500 inhabitants and upcoming projects declared in a time horizon of 10 years increase to up to 25 000 inhabitants.

The strategy of the sub-urban rail has its significant justification in terms of the development of the city of Bratislava, which is enormously developing more in its agglomeration than in its own territory. Taking into account the development of satellite towns of Pezinok, Senec, Šamorín, a range of development between the satellite cities of Bratislava agglomeration, it creates a radius in the range of 25 km. The second ring of the urbanization of the city of Bratislava consists of individual county cities and towns at a distance of 30-50 km from the city centre. These are Malacky, Trnava and Dunajská Streda. Just in terms of simple principles of geography and urban development is possible to declare a demand of the suburban rail public transport, which however must have a clear city corporate function. Therefore, it was addressed already in past, where they were some tracks of tram-train, examples of which can be seen in several cities of Europe. Bratislava in terms of its own development should not be an exception, because of its internal city area together with its agglomeration cannot ensure only by conventional rail transport.

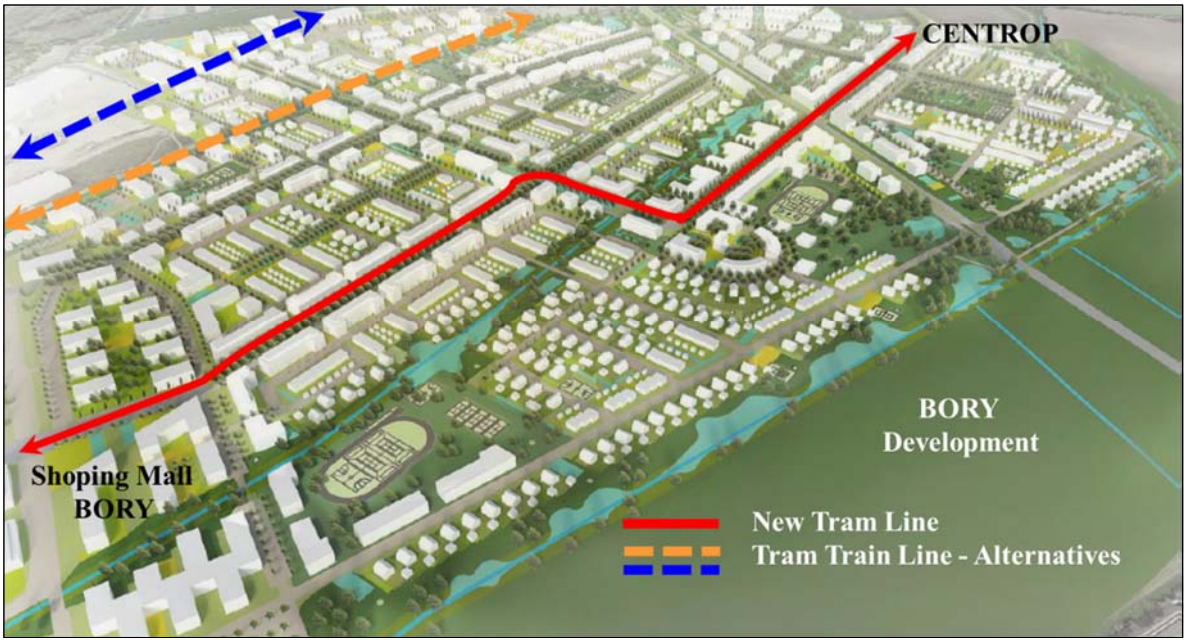

Figure 5 – Tracking of the new tramway in developing area BORY

The particular solution of designing the tram-train connection to the railway line in its southern part was studied in 3 versions. In Figure 6 is a scheme of variants, which are connected in the railway infrastructure, of course according to the principles of international rules, which must be a flyover in collision link. In addition, in the southern part of the territory is a terminal, which will serve the rail, tram-train, tramway line and suburban bus transport [10.]

7. Tram-train design

To investigate the area public transport as deep as possible, the tram-train tracks are designed in three variants which are interchangeable. All variants are designed according to the Slovak technical standards with design speed 80 km/h. Where it is not possible the design speed is reduced to 50 km/h with local restrictions exceptionally to 15 km/h. The complete layout of the variants is displayed in the Fig. 2. The detail of the tram-train connecting the international railway link is displayed in the Fig. 6.

The *Variant A* enters the Bory urban area and services its central axis. In the CENTROP the tram-train is also kept in the centre of land proposed for build-out, ergo the accessibility from the investigated

area is attractive. *Variant A* strictly follows the proposed communication system according to the urban study [1] and land aggregations process, that fact causes the design speed restriction in Bory area to 50 km/h and to 15 km/h in one junction. The tram-train track is parallel to the street tram while the minimal distance between them is 255 m.

The *Variant B* goes inside Bory but turns into the retail zone to increase the offset from street tram and to improve the area serviceability. An essential disadvantage of the *Variant B* is the necessity to reconstruct four existing roundabouts and a passage of finished highway. After servicing the commercial zone the track aligns to the road II/505 by radiuses which require the design speed reduction, and continues as a median of future four-lane highway. Later the variant crosses the biocentre to enter the CENTROP. This variant tends to service the eastern part of CENTROP to make the track accessible also from Záhorská Bystrica.

The *Variant C* does not enter the Bory inner area but rather heads around it to align to the road II/505 sooner than variant B. The track stays parallel from Bory to Volkswagen car factory. After forming a terminal for the factory and Devínska Nová Ves, the tram-train turns into the CENTROP and heads north. The *Variant C* in comparison to the other variants does not require a long bridge over the railway and road II/505, but crosses under the railway and therefore requires a bridge construction on existing railroad. Neither horizontal nor vertical alignment of this variant does restrict the track design speed. The position in the middle of future city boulevard has a strong urban and aesthetic value. Along with that it enables the area in the west from the investigated land to develop and be serviced.

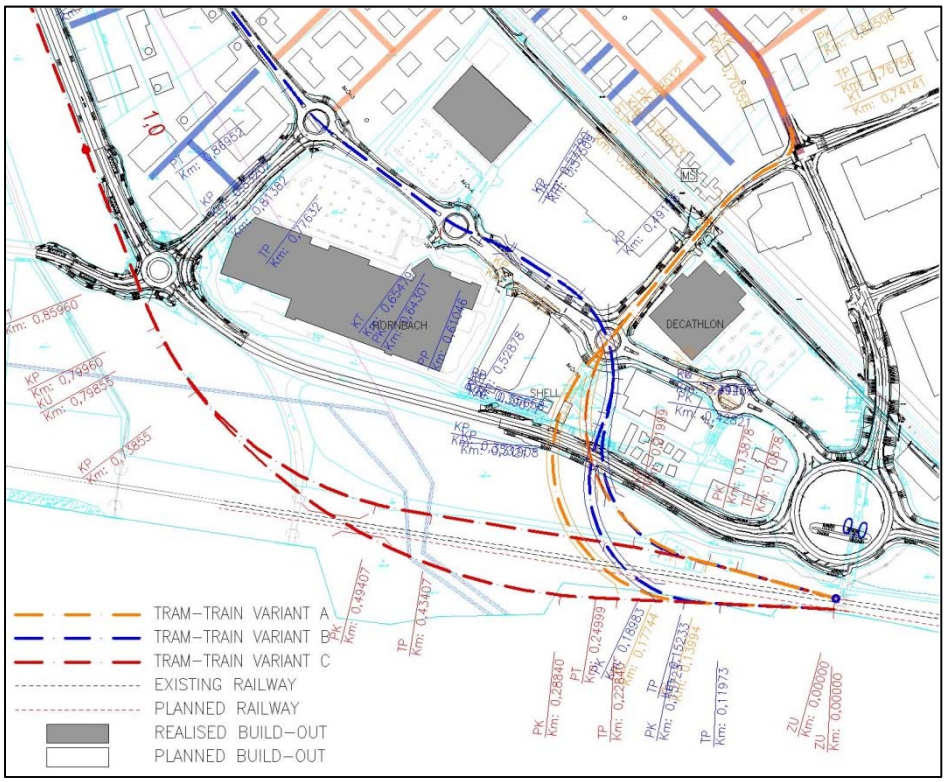

Figure 6 – Tram-train connection to the railway network

All the variants then cross the D4 motorway by a flyover and with a large radius connect to the abandoned railway to Stupava. For optimal service of the area, we preliminary recommend the *Variant C* to be elaborate in detail, because it has sufficient offset from the urban tram, it achieves the speed of 80 km/h in the whole route and services the land on both sides of the road II/505 along with Volkswagen car factory.

8. Results and discussions

The results from this article have significance for the next decisions of the City of Bratislava and developers as well. The developers have now the main role because they are the owners of the land and they have an interest to create a multifunctional land together with a high quality of living standard. This area will be close to the Bratislava down town and open towards direction to Vienna. Of course for that is a first priority to have specific transport infrastructure. The discussion is huge but for that we need many scenarios with technical solutions and answers. The background of the industrial function, services of an existing immense shopping mall, extending the neighbouring city boroughs and satellite city are a reason for a solid traffic engineering and planning work. This article has a goal to open this box and start a professional discussion.

9. Conclusions

The territory of the BORY and CENTROP lying in the north-western development direction of the city of Bratislava in Lamačská Brána are some of the most potential developing territory in Central Europe. To create a sustainable vision for the future of the build-up area is from the first phases of the project a need to take into account the transport serviceability inside of all kind of documentations from feasibility and EIA studies through each level of design documentations. In the framework of these arrangements are determined the corridors for the future transport network of the territory. In the territory of the BORY a huge construction activities of the shopping area has been started and a residential zone is being prepared. The next steps of the work must be directed by comprehensive tools for the development of this great area, which is, in the area of transport system, recommended to address in these steps:

1. design and assessment of the integrated rail track transport by tram-train,
2. design and assessment of the integrated rail track transport by tramway line,
3. create a policy for integrated public transport terminal,
4. the assessment of the proposed scenarios of road/street network based on the new approach of urbanization around the territory, together with the neighbourhoods of existing boroughs and backgrounds of the agglomeration of Bratislava.

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