Intermediate stage traffic technical solution of prince Branimir Street in Zagreb

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ABSTRACT: Traffic network of each city is determined by Urban Master Plan (UMP) which reflects in traffic corridors of specified width. The urban master plan is plan of the local level and in our case covers 220 km² for the city of Zagreb. The plan gives indicators for the construction, renovation and protection of space in the area of Plans scope and to ensure spatial plan preconditions for realization of traffic and infrastructure projects. On the area of a large city is a complex interdependence of traffic infrastructure. The quality of traffic infrastructure is manifested as accessibility and mobility of space and advancement of new traffic corridors as a basis for a sustainable development. In this paper, the traffic technical solution of prince Branimir Street in Zagreb, road section from Zavrtnica to Vjekoslav Heinzel Street, has been elaborated. Construction of this road section was initiated in 2012 through the I. phase of construction but only part of the width of the planned traffic corridor. As a result of that property-right issues were partially solved. A fully built, in a full corridor width, was planned for II. phase of construction. In the meantime the property-right issues were solved but still not in a complete width of the planned corridor. Because of that, it has been approached to preparation of technical solution which would keep the elements constructed in a I. phase, and built new ones in intermediate stage which would also be incorporated in the II. phase of construction. In intermediate stage, elements which improve traffic conditions, should be constructed, such as enhancement of traffic capacity and satisfying level of service. In the paper were analyzed all the components and traffic technical solutions of intermediate stage.

1 INTRODUCTION

1.1 General

Traffic network of the city of Zagreb is determined by Urban Master Plan (UMP)—Urban master plan of the city of Zagreb (2007) which reflects in traffic corridors of specified width for road categorized as urban highway, city avenue, the main street, city streets and corridors of public transportation areas. The plan gives indicators for the construction, renovation, modernize and upgrade existing streets, solve stationary traffic and improve bicycle traffic. Transport situation in the city of Zagreb is a direct consequence of Urban Master Plan (UMP) planned traffic corridors. Figures 1 and 2 showing Urban Master Plan (UMP) of the city of Zagreb—purpose of space and road network. Parts of the city in which they are built traffic corridors into full width, from the point of road capacity, function with satisfactory level of service. In other parts of the city is very low capacity of road network, reduced availability of the city center and there is a problem of structure and organization of traffic flows. Also, the development of transport network doesn’t follow the development of the city. Planned traffic corridors in other parts of the city are characterized by no kind of construction (not started any construction in the planned corridor) or kind of construction only in the part of the planned width or discontinuity of development corridors with the level of development of planned width or in full width of planned corridor.

The cause of this condition partly lies in the fact that it is an urban area where there are built residential business and commercial objects and any construction of traffic corridors is actually a “puncture” through the built area with unavoidable demolition of existing buildings. Prince Branimir
Figure 1. Urban master plan of the city of Zagreb—purpose of space.

Figure 2. Urban master plan of the city of Zagreb—traffic network.
Street, as one of the main traffic corridors from the center to the eastern part of the city is an example of discontinuity corridor, where for many years the corridor was interrupted on the part of the Avenue Marin Drzic to the Vjekoslav Heinzel Street and all because of the residential business and commercial objects within the plan of the early traffic corridor.

Few years back on the part of Zavrtnica to the Vjekoslav Heinzel Street was built only one part of the planned width of the corridor as a kind of “junction” of the old and new Branimir Street. The construction of “junction” has been made the continuity of traffic corridor but due to insufficient road capacity as a result of partially development the junction is only a “bottleneck”.

The quality of traffic infrastructure is manifested as accessibility and mobility of space and advancement of new traffic corridors as a basic for sustainable development—Book of regulations (NN 110/2001) & Book of regulations (NN 34/2005).

1.2 Position and role in city traffic network

Prince Branimir Street has been planned by the Urban Master Plan (UMP)—Urban master plan of the city of Zagreb (2007) to be a traffic corridor of main city street from main railway station to town district Sesvete and represents one of the main traffic corridors from the center to the east side of the town. Figure 2. showing prince Branimir Street in city road network. For years there were only two separated parts: part from main railway station to Marin Drzic Avenue and part from Vjekoslav Heinzel Street to Dubrava Street in city district Sesvete.

Between 2005 and 2008 it has been constructed a part from Marin Drzic Avenue to Zavrtnica in a section with dual two-lane carriageway each with two traffic lanes and pedestrian-bicycle way.

Continuity of traffic corridor couldn’t be realized because there hasn’t been built a part from Zavrtnica to Vjekoslav Heinzel Street in a length of 350 meters so that this part has been analysed in this paper.

In Urban Master Plan (UMP), in range of a grip, prince Branimir Street has been planned in a width of 50 meters. On the south, it borders on railway corridor and Urban Master Plan (UMP) Heinzel-Radnicka-railway line. Figure 3 showing grip of the project. On the north side corridor borders on Urban Master Plan (UMP) area bounded with streets Banjaviceva-Heinzel-prince Branimir-Zavrtnica.

2 DEVELOPMENT OF PHASES OF CONSTRUCTION

The building of the section initiated in 2012 through the I. phase of construction within partial width of the planned street corridor as a result of unsolved property-right issues—Decision 2006 (12). The building of entire width corridor was planned through the II. phase of construction. The I. phase of construction was finished in 2012.

In years after achieving the I. phase of construction, additional property-right issues were solved. But since they were not solved entirely, it was not possible to build the planned II. phase of construction. That situation led to finding a new technical solution with the aim to improve the conditions
of ever-increasing traffic: increasing capacity and achieving satisfying level of service. All components of road design build in the I. phase and planned in the II. phase of construction were analyzed and resulted in a traffic and road design of an intermediate stage of construction. All design components built in the I. phase of construction are preserved and upgraded with additional components, entirely compatible with the planned II. phase of construction—Decision 2006 (16).

3 TECHNICAL SOLUTION

Basic design of the I. phase of construction was single lane carriageway with no additional traffic lanes at Zavrtnica and Heinzelova intersections (Elipsa-S.Z. Ltd., 2012). Footpath in minimum width was designed only on south side of carriageway. At time when designed, it was not sufficient for existing traffic volume, but was only possible due to unsolved property-right issues. The I. phase resulted in connection of existing unlinked segments of prince Branimir Street but with congestions on Heinzelova Street intersection. Figure 4 showing technical solution situation of the I. phase of construction.

In the II. phase of construction was planned dual-two lane carriageway with additional traffic lanes for left and right turns at Zavrtnica and Heinzelova intersections—Elipsa-S.Z. Ltd. (2014). Footpath in minimum width was designed on south side of carriageway. On north side of carriageways footpath with cycle lanes was designed.

Intermediate stage is presented with combined carriageways from the I. and the II. phase of construction. Intermediate stage in fully use carriageway built in the I. phase of construction and build north side corridor carriageway as planned in the II. phase but with modification on east side necessary to form intersection. Main difference in design of intermediate stage and design of the II. phase of construction is on intersection with Heinzelova Street. Design of intermediate stage not allow direct left turn on intersection with Heinzelova Street. Left turn is achievable indirectly on intersection with Zavrtnica Street. Figure 5 showing technical solution situation of intermediate stage of construction.

The II. phase of construction planned to be activated as soon as property-right issues are solved. Figure 6 showing technical solution of planned the II. phase of construction.

Each component of road design built in the I. phase and planned in the II. phase of construction were analyzed and redesigned, resulting in new combined technical solution of intermediate stage—Rehlicki (2016). Cross-sections of a corridor defined through the I. phase, the II. phase and intermediate stage are shown in Figure 7.

3.1 Horizontal alignment

In the I. phase of construction was built one single lane carriageway, partially on south and north side of planned corridor. Horizontal alignment is defined with two curves 80 meters in radius connecting three straights. Design speed of 50 km/h is determined by curves radius.

In the II. phase of construction are planned two duo lane carriageways, one on south and one on north side of planned corridor. Horizontal alignment is defined with one axis. Design speed is 50 km/h and determined by traffic regulation.

Intermediate stage, according to drive direction, has two horizontal alignments. For drive direction west-east horizontal alignment completely match the I. phase of construction. For drive direction east-west horizontal alignment match north carriageway horizontal alignment of the II. phase of construction.

Traffic corridor is defined by an unique axis set in central median on which are based all the
Figure 5. Intermediate stage of construction.

Figure 6. Planned the II. phase of construction.

Figure 7. Cross-sections of a corridor.
other elements of cross-section across the width of the planned corridor—Korlaet (1995). Because of phase building in the I. phase and traffic technical solution, it was necessary to define separate axis that will best define the elements of the cross-section for the purpose of phase building. In a transport-functional sense, considering directions of the vehicle, traffic technical solution consists of two axis, different for every vehicle direction. Figure 9 showing defined axis.

3.2 **Vertical alignment**

Vertical alignments of the I. phase, the II. phase and intermediate stage are shown in Figure 8. Vertical alignment deviation in intermediate stage in regard to the II. phase of construction is result of keeping existing carriageway on north side of corridor, build in the I. phase of construction, and super elevation, changing grade from existing carriageway to carriageway planned through the II. phase of construction.

3.3 **Pavement structure**

The same pavement structure as defined in the I. phase is retained in the planned II. phase of construction. As shown in Figure 10 total thickness of existing pavement structure is 61 cm. Extension of existing carriageway while maintaining the same layer thickness, cross fall and subgrade fall requires, on extended side, pavement structure in total thickness of 51 cm. The frost-resistant pavement structure requires total thickness (depth) of 57 cm. Due to keeping existing pavement layer thickness and insuring frost-resistant pavement structure, it was necessary to reduce subbase layer thickness from 30 cm down to 26 cm and reduce subgrade fall from 4% down to 3%.

Layer thickness of pavement and subbase, based on layer thickness and subgrade fall, designed in the I. phase of construction are recalculated and redefined for intermediate stage of construction—Babic (1997). Layer thickness and subgrade fall of intermediate stage pavement structure is shown in Figure 10.

![Figure 8. Vertical alignments.](image)

![Figure 9. Defined axis.](image)
Validity and sustainability of intermediate stage technical solution is shown in Table 1. Almost 50% of carriageway built in the I. phase of construction should be removed to be upgraded to the II. phase technical solution. Unlike the I. phase of construction, less than 2% of carriageway built in intermediate stage should be removed to be able to upgrade to technical solution of the II. phase of construction.

### 4 CONCLUSION

Building of traffic corridors in a full width represents a complex project, which extends through long time period, require a coordinate work of large number of city and municipal services. It includes planning and harmonization of activities, solving property-right issues and insurance of financial resources, both in the design stage and building stage. A transportation system is characterized by incoherence of urban areas, low road capacity, reduced availability of town center, adverse traffic effect on environment and increased degree of motorization. Systematic construction of main traffic corridors should be a priority and the only measure of sustainability of existing traffic network. The level of construction should correspond to development stage of urban area. This is achievable only through multi phase of construction. The development of the corridor is achieving through construction phasing in a way that next phase is a suffix to a previous phase. It is unacceptable to tear down already built part of infrastructure, except in case when there was a long period between two phases. Traffic system is inimitable so it is necessary to continuously invest in its development.

Today's low road capacity of traffic infrastructure and lowered availability of town center is caused not only by inappropriate building but also by absence of systematic traffic control. Only combination of measures based on urban planning can contribute to growth of motorization degree and increased road capacity.

As shown in this case, originally planned construction through two phases, due to the impossibility of solving property-right and legal issues in the planned time frame, led to new phase of construction—intermediate stage. Each phase corresponds to traffic needs but taking into account the spatial possibilities at its time of construction.

### Table 1. Comparative overview carriageway upgradeability through phases of construction.

<table>
<thead>
<tr>
<th></th>
<th>First phase</th>
<th>Intermediate stage</th>
<th>Second phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carriageway built, planned [m²]</td>
<td>2304</td>
<td>4534</td>
<td>6820</td>
</tr>
<tr>
<td>to remove in second phase [m²]</td>
<td>1104</td>
<td>81</td>
<td>-</td>
</tr>
<tr>
<td>realized in year</td>
<td>2012</td>
<td>-</td>
<td>2016</td>
</tr>
<tr>
<td>cost in all* [million Kn]**</td>
<td>6.8</td>
<td>-</td>
<td>9.0</td>
</tr>
</tbody>
</table>

* Realized cost in all include: carriageway, footpath, traffic lights, traffic signs, road markings, sewer, lighting, telecommunication infrastructure, landscaping, urban equipment.

** 1 Kn = 0.133€.
In May 2016 property-right issues were solved entirely. After four years in use, 48% of carriage-way built in the I. phase was removed and in July 2016 was built full width corridor according to planned the II. phase of construction. So there was no need for application of intermediate stage. This paper was not intended to cover feasibility analysis of construction for each phase but to show that for each stage of development there is appropriate technical solution.

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