TRAFFIC ANALYSIS OF SLAVONSKA AVENUE IN ZAGREB

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Abstract

This study reviews a traffic analysis of a segment of Slavonska Avenue in Zagreb, between Čavićeva Street and Ljudevita Posavskog Street. The analyses employed a traffic model provided by "Spatial and traffic study of road and railroad transport system of greater Zagreb area". An analysis of level of service and capacity has been performed. The present situation has been analyzed as well as three new variants. A broader concept of development of Slavonska Avenue has been reviewed. The variants analyzed have been assessed, and a design for optimum development of Slavonska Avenue has been proposed.

Keywords: Slavonska Avenue, traffic analysis, traffic model, level of service

1 Introduction

The segment analyzed is the eastern section of central arterial road spanning Jankomir interchange on the western part of Zagreb motorway bypass and Ivanja Reka interchange - on its east. The arterial road consists of three parts: Ljubljanska Avenue, Zagrebačka Avenue and Slavonska Avenue (Fig. 1), and it has been formed in the middle of the last century as a thoroughfare through Zagreb, carrying the main route of the former state.
Between 1975 and 1985, the two-lane arterial road was rebuilt in stages and transformed into a four-lane road, while Zagrebačka Avenue has been widened in 2006, to accommodate three traffic lanes in each direction instead of two, with intersections regulated by traffic lights. The next task comprises reconstruction of the eastern part of Slavonska Avenue.
Peripheral zones of these avenues are of suburban type, while the central part of the avenues transits a densely populated urban area. Segment of Slavonska Avenue encompassed by this review runs through an industrial area.

Figure 1 Zone of the Slavonska Avenue segment under review

In its entire length, Slavonska Avenue comprises two traffic lanes for each direction of traffic. In this specific zone under review, Slavonska Avenue intersects a railroad and 5 roads (Fig. 2): Čavićeva Street, Grada Gospića Street, Street 7 (at Green market), Čulinečka Road, Resnik III Street. A grade separated intersection at Ljudevita Posavskog Street, located adjacent to a boundary of this zone, has been carried out in late 2009.
The zone reviewed comprises four intersections regulated by traffic lights and two flyovers (Fig. 4a). A flyover spanning Grada Gospića Street and a railway flyover, which has no direct effect on Slavonska Avenue traffic flow, however it shall have certain effect on future construction designs. This segment of Slavonska Avenue is somewhat shorter than 5km.

2 Investigation: Traffic Counting

In November 2008, traffic counting has been performed in fifteen minute intervals during 4 days between 6:00 and 18:00 hrs at 5 intersections and at the railroad intersection. The traffic counting encompassed all traffic directions at all of the intersections of Slavonska Avenue as well as an intersection of Grada Gospića Street and a service road running parallel to Slavonska Avenue to its south (Fig. 4a).
The central segment of the avenue carries an average daily traffic of 49000 vehicles in both directions. Trucks comprise 8% of the traffic flow, while approximately 11% of the traffic exits at each of the intersections. Two peak periods have been identified. Average disproportion of morning peak traffic in each of the directions equals 38:62, with predominant westbound traffic, i.e. towards the city centre, while during afternoon peak traffic it is 56:44, with predominantly eastbound traffic, away from the city centre.

3 Zagreb Area Study Traffic Model

During preparation of "Zagreb area traffic study" [2] a traffic model has been developed. 2007 has been used as a base year for the model, and the model has been calibrated using traffic counting data of year 2008 using VISUM software.
The model analyzes planned transportation route network and assigns traffic to the planned network expected in years 2013, 2018 and 2030.
This design of Slavonska Avenue comprises a more detailed analysis of the planned network in its specific area. Therefore traffic volume has been assigned to time intervals in 2008, 2010, 2013, 2015, 2018 and 2030.

Figure 2 Planned network

According to the Zagreb area traffic study, in 2013, extended Vukovarska Avenue should be opened, as well as a connecting road to Street 7 (at Green market) as well as Koledinečka Street. A reconstruction of north - south corridors (Grada Gospića Street, Čulinečka Road) is scheduled for 2018, while in 2030 a road running parallel to Slavonska Avenue, to its south, and a road within the railroad corridor are expected to be in use. Fig. 2 indicates development

of planned road network in specific zone of the study. Fig. 3 shows traffic volumes in 2030. It is the final year of the Zagreb area traffic study. The parallel road carries approximately 20000, while the road situated within the railroad corridor carries somewhat less than 49000 vehicles per day. Quality of traffic flow is indicated in Table 1.

Figure 3 Traffic volumes along the planned network in 2030

Table 1 Volume/Capacity Ratio in the Segment Reviewed

Volume/capacity	2lane0	3lane0	2lane1	3lane1
2008	1.16	-	-	-
2010	1.20	0.97	0.80	0.58
2013	1.15	0.94	0.81	0.59
2015	1.18	1.00	0.85	0.64
2018	1.32	1.12	0.96	0.74
2030	1.16	0.99	0.85	0.68
Average	1.20	1.00	0.85	0.65

4 Variants analyzed

The following variant developed situations have been analyzed (Fig. 4):

- The existing situation (Fig. 4a) – four-lane avenue with intersections at a grade; two traffic lanes in each directions; intermittent traffic flow due to intersections at a grade regulated by traffic lights.
- Previous plans developed by city authorities (Fig. 4b) which were identified as the initial situation of this analysis.
- Variant 1 (Fig. 4c) – Six lane avenue with intersections at a grade; three traffic lanes in each direction.
- Variant 2. (Fig. 4d) – Four-lane avenue with grade-separated intersections; two traffic lanes in each directions.
- Variant 3. (Fig. 4e) – Six-lane avenue with grade-separated intersections; three traffic lanes in each directions.

4.1 The existing situation – four-lane avenue; intersections at a grade

Slavonska Avenue is a four-lane avenue with two traffic lanes in each direction, with five intersections regulated by traffic lights. It spans Grada Gospića Street by a flyover, and a railroad overpass spans the avenue. Grada Gospića Street connects to Slavonska Avenue via directional ramps, while south of the avenue, the intersection is served by a service road and two adjacent intersections: Čavićeva Street and Street 7 at Green market.

Capacity and level of service (LOS) analyses in compliance with HCM method have been made for individual intersections and for the trunk route.
Tables 3 and 4 indicate basic properties of traffic flow via a group of westbound traffic lanes running straight along Slavonska Avenue (the northern carriageway) during morning peak hour.

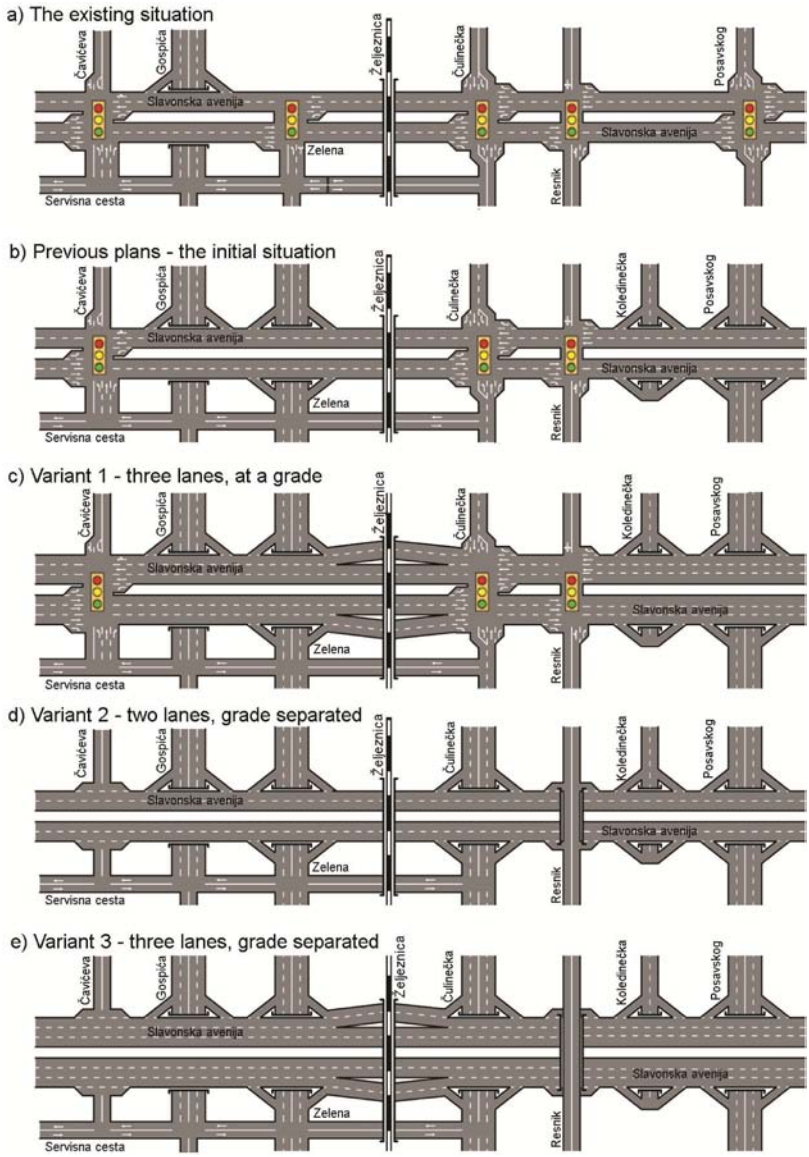

Figure 4 Schematic overview of variant designs of Slavonska Av.

The last line provides values for the entire segment, between Ljudevita Posavskog Street and Čavićeva Street. Average travel time equals 1132 seconds, the segment is 5.75km long, therefore average travel speed is 18.3km/h, while LOS is F.

Tables 5 and 6 indicate basic properties of traffic flow via a group of eastbound traffic lanes running straight along Slavonska Avenue (the southern carriageway) during afternoon peak hour.

Table 2 Slavonska Avenue, the northern carriageway, the morning peak period

Segment	v/c	C (veh/h)	Delay (s)	LOS
Resnik	1.08	1971	172.2	F
Čulinečka	1.33	1435	628.7	F
Green market	0.86	2409	16.8	B
Čavićeva	0.99	1506	49.1	D

Table 3 Slavonska Avenue segment LOS

Segment	T (s)	L (km)	S (km/h)	LOS
Resnik	236.2	1.39	21.2	F
Čulinečka	664.7	0.69	3.7	F
Green market	106.8	2.00	67.4	B
Čavićeva	124.2	1.67	48.4	C
Total	1132.0	5.75	18.3	F

Table 4 Slavonska Avenue, the southern carriageway during the afternoon peak period

Segment	v/c	C (veh/h)	Delay (s)	LOS
Čavićeva	1.280	1474	537.5	F
Green market	0.970	1779	35.8	D
Čulinečka	1.130	1435	269.9	F
Resnik	0.970	1971	18.6	B

Table 5 Slavonska Avenue segment LOS

Segment	T (s)	L (km)	S (km/h)	LOS
Čavićeva	585.5	1.00	6.1	F
Green market	110.9	1.67	54.2	C
Čulinečka	359.9	2.00	20.0	F
Resnik	54.7	0.69	45.4	C
Total	1111.1	5.36	17.4	F

4.2 The existing plans – the initial situation

The existing plans of the City authority call for reconstruction of the intersection at Green market (Street 7), through its execution as a grade separated crossing, and addition of the northern access route; appropriate design documents have been developed. Future Koledinečka Street is to connect to Slavonska Avenue in a grade separated intersection. Planned reconstruction of Ljudevita Posavskog Street intersection as a grade separated intersection has been completed in late 2009.
The initial situation of this analysis entails a four-lane avenue with two traffic lanes in each driving direction. In this variant of its development, Slavonska Avenue comprises three inter-

sections regulated by traffic lights: Čavićeva, Čulinečka and Resnik III as well as four grade separated intersections. Capacity of the avenue is limited by capacity of its intersections regulated by the traffic lights, thus determining a capacity at Čulinečka Road to 36000 vehicles per day in both driving directions, in terms of traffic flowing straight ahead. Figure 4b provides a schematic overview of this variant.

4.3 Variant 1: Six-lane avenue with intersections at a grade

Three new variants have been analyzed, the first among them is a six-lane avenue with intersections at a grade, with three traffic lanes in each driving direction. In respect to the initial situation, it is necessary to carry out the following works: present-day Grada Gospića Street flyover need be widened by one traffic lane for each of the driving directions; as piers of the railroad overpass are adjacent to the roadway, it is necessary to bypass them and separate the carriageways for each of the driving directions; add one traffic lane for each of the driving directions along the length of the route.
The aforementioned activities yield a six-lane avenue with three intersections regulated by traffic lights: Čavićeva, Čulinečka and Resnik III. The remaining four intersections are grade separated. It is necessary to add left turn lanes, which may be problematic due to constrained space available. Between 2008 and 2030, traffic volume averages at 60000 vehicles per day (see Table 1). Daily capacity is approximately 60000 vehicles. The volume/capacity ratio equals 1, which means that this variant creates a congested avenue, providing insufficient LOS. Figure 4c provides a schematic overview of Variant 1 of the analyzed segment of Slavonska Avenue.

4.4 Variant 2: Four-lane avenue; grade-separated intersections only

This variant entails removal of traffic lights at Čavićeva Street intersection. The intersection would comprise entrance and exit directional ramps at the northern and the southern carriageways, while north – south communications would be served by the service road and Grada Gospića Street. Grade separation of Čulinečka Road is planned by means of execution of a roundabout below Slavonska Avenue. At Resnik III intersection, traffic lights are to be removed, a flyover is to be executed across Slavonska Avenue, as well as entrance and exit directional ramps on the northern and the southern carriageways.
Variant 2 (Figure 4d) would comprise two traffic lanes in each driving direction along its entire length, and seven grade separated crossings. Between 2008 and 2030, traffic volume averages at 69.000 vehicles per day. Daily capacity is approximately 80.000 vehicles in both driving directions. The traffic volume to capacity ratio is 0.85, which is close to admissible LOS limit (Tables 1 and 2).

4.5 Variant 3: Six-lane avenue with grade-separated intersections only

This variant (Figure 4e) proposes a six-lane avenue with grade separated intersections only and with three lanes in each driving direction – i.e. with all of the intersections functioning exactly as in case of the Variant 2, along with additional traffic lanes in both driving directions along entire length of Slavonska Avenue. Traffic flows would be continuous. Between 2008 and 2030, average traffic volume would slightly exceed 77,000 vehicles per day. Since the traffic volume to capacity ratio is 0.65 it follows that the LOS is entirely sufficient.

5 Concluding Consideration

The six-lane avenue with the intersections at a grade – the Variant 1, comprises volume to capacity ratio of 1, yielding an unacceptable LOS. Left turns may not be properly addressed due to spatial constraints. The investment is worth 379.6 million Kuna; it is assessed as unjustified.
The four-lane avenue with the grade separated intersections only – the Variant 2, comprises volume to capacity ratio of 0.85. It is worth 338.0 million Kuna; it is assessed as justified.
The six-lane avenue with the grade separated intersections – the Variant 3, comprises volume to capacity ratio of 0,65, yielding a satisfactory LOS. The investment is worth 515.0 million Kuna; it is assessed as premature.
Should the variant proposing the four-lane avenue with the grade separated crossings between Čavićeva Street and Ljudevita Posavskog Street be adopted, only three intersections regulated by traffic lights would remain along entire road section of Zagrebačka Avenue and Slavonska Avenue between Selska Road and Ivanja Reka interchange: Vrbik, Kruge, Ivanja Reka and one set of traffic lights facilitating a pedestrian crossing at Radnička Road. Reconstructing those intersections as grade separated intersections with two lanes in each driving direction would yield a four-lane avenue with grade separated interchanges along its entire route. The following six existing structures would not have to be widened: Selska flyover, Savska underpass, Hrvatske bratske zajednice underpass, Držićeva flyover, recently completed Heinzelova flyover, Grada Gospića flyover. Thereby maximum benefit would be achieved through minimum investment, in the shortest possible time.
Average travel speed during peak periods is approximately 17km/h. The lowest average speed is less than 4km/h, when driving from Resnik in the morning. The v/c ratio is 1.33 which means that the LOS is inadequate. Since Čulinečka Road represents a bottleneck, the following is proposed as a matter of priority: grade separation of Čulinečka Road, followed by removal of the traffic lights at Čavićeva Street and Resnik intersections. The first stage would provide the grade separated four-lane avenue – the Variant 2 by 2013, and afterwards, depending on traffic demands, the grade separated six-lane avenue - the Variant 3, beyond 2018.

References

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