Study Concerning the Conflict Points within an Urban Signalized Intersection

Ariadna ILIUȚ*, Janos TIMAR, Daniel MATEI, Corneliu COFARU

Department of Automotive and Engines, The Transilvania University of Braşov, Braşov, 50036, Romania

Abstract The subject of this paper is included in the "Automotive Technology" area, namely in the "Road Traffic and safety" section, since it concerns the analysis of the conflict points within an urban signalized intersection.

The analyzed intersection represents a part of an important road that is in fact the entrance into the town from the Bucharest direction. It has been studied using the real data collected in the field and it also has been analyzed using the intermediary, evacuation and access times that a vehicle needs in order to pass safely through the intersection. In the end of the paper, the results of the experimental data are discussed and the proper conclusions are stated.

Keywords: Road traffic, traffic flow, intersection, conflict point.

1. Introduction

The road traffic worldwide becomes more crowded and less safe every day, and this rule also applies in the case of our country.

Here, in the past, the transport was not a very big problem due to the small number of vehicles that were on the roads. During the last years, since the number of vehicles (automobiles and transport vehicles) increased, in the large cities of our country a lot of traffic problems occurred. Braşov is one of these cities that will be the subject of the present study.

The traffic problems that are the most disturbing in our town are the rush hour traffic jams. They are caused by the large number of vehicles that move throughout the town at certain time intervals.

If we take into account the fact that in the whole country the total number of vehicles has an increasing tendency, one can only ask if these problems are only the beginning of traffic problems that we will have within Braşov, too. Another question that occurs is if the street network, already suffocating, is able face the new traffic demand and how.

The aim of this study is to analyze the problems that occur within an urban signalized intersection from the conflict points point of view and also, to try to explain what happens and why.

The intersection that is the subject of this study represents a part of an important entrance in the town. As the name says, the Calea Bucureşti Street is the entrance from the Bucharest direction, but also it makes the connection between two very important tourist areas. This street is also the entrance for the Săcele town and it makes the connection of Noua neighborhood with the center of the town.

Another road traffic component in the area which also generates problems is the fact that the goods demand grew and it determined the presence of malls. They imply various car dealerships in the area, many vehicles, pedestrians and also gas stations, for which people do not have proper access and exit areas, and no alternative routes.

All these facts determine a very difficult traffic during rush hours; the traffic jams being its result.

The main direction of the traffic has the direction from the entrance into the town and toward the central areas and from the town to the big shops, which represent the biggest commercial area.

2. Experimental

The Calea Bucureşti-Zorilor Street intersection is one of the important intersections and its analysis is accomplished in this section.

This intersection is one of interest because the Zorilor Street is the one that collects a part of the

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traffic from and into the Răcădău and Steagu neighborhoods. The Zorilor Street represents the access to one of the most important market places in the city and the Orizont 3000 shopping galleries.

This intersection is a classical one, having four approaches. Here, the main traffic flow is crossed by a smaller one that needs access to the market place in the area, as it can be seen in the picture below:

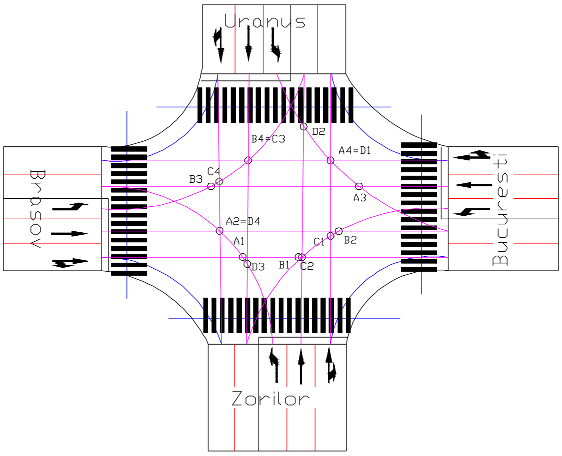

Fig. 1: The Calea Bucureşti – Zorilor Street intersection in Braşov and its conflict points.

The flow from Zorilor Street is not too large compared to the main flow of vehicles, and from the Uranus Street also. So, although the streets are very wide, the length is small. They get wider in the vicinity of the intersection. The middle lane (for the left turn) occurs near the intersection. Also the same thing can be said for the main direction. All the middle lanes, for the left turn, are formed in the vicinity of the intersection. The main approaches are wider only because they have to sustain public transportation vehicles which have wider lanes. So the lane structure for this intersection is the same for all approaches. In the case of all approaches the first lane is meant for right turn and forwards, the second lane is only for forward direction and the third lane for the left turn. There are two receiving lanes for all approaches, as it can be seen from the following pictures, namely Fig.2 and Fig.3.

In the case of the traffic lights phase planning, we observed that the first phase is green light for the main direction together with the right turn, and pedestrian crossing. The second phase includes the left turn from Bucureşti direction onto Zorilor Street and the one from the town onto Uranus Street. The third phase allows the right turn and the forward motion for the secondary street (the crossing of the main traffic flow). And the last one is for the left turn from Uranus Street to Bucureşti direction and towards the town from Zorilor Street.

Fig. 2: The main traffic flow in the Calea Bucureşti – Zorilor intersection.

This phase planning will give almost a perfect symmetrical intermediary time calculation, as seen in Table 1.

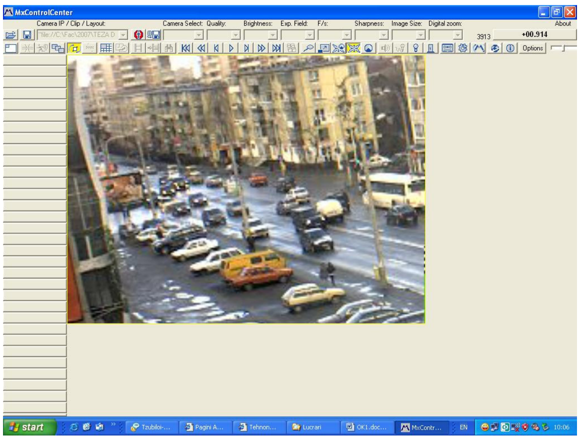

Fig. 3: The Calea Bucureşti – Zorilor intersection viewed using a Mobotix video surveillance camera.

Table 1: The phase planning and the intersection coefficients

Calea Bucuresti – Zorilor Street					
			4 Evacuates – 1 Enters		
	Da	De	Ta	Te	Ti
A1	20,2	12,9840	1,4532	5,0627	3,6095
A2	16,89	18,4290	1,2151	6,0527	4,8376
A3	12,78	20,4030	0,9194	6,4116	5,4922
A4	16,85	14,6646	1,2122	5,3683	4,1560
				Ti max	5,4922
			1 Evacuates - 2 Enters		
B1	27,748	24,8	1,9962	7,2111	5,2148
B2	29,721	28,34	2,1382	7,8547	5,7165
B3	22,516	28,39	1,6198	7,8638	6,2439
B4	27,684	24,8	1,9916	7,2111	5,2194
				Ti max	6,2439
			2 Evacuates - 3 Enters		
C1	15,66	17,7368	1,1266	5,9268	4,8002
C2	12,6	22,5305	0,9064	6,7984	5,8920
C3	12,5	15,0498	0,8992	5,4383	4,5390
C4	15,56	20,3901	1,1194	6,4093	5,2898
				Ti max	5,8920
			3 Evacuates - 4 Enters		
D1	20,484	21,03	1,4736	6,5256	5,0519
D2	14,525	25,32	1,0449	7,3056	6,2606
D3	12,146	27,49	0,8738	7,7002	6,8263
D4	18,429	22,75	1,3258	6,8383	5,5125
				Ti max	6,8263
				Ti	24,454

In order to understand the table we have to know that:

$$V = D / T \qquad (1)$$

In words this means that the speed (V) is equal with the ratio between the distance (D) and time (T).

In traffic, the maximum speed of the vehicle is limited by legislation. The distances (the geometry of the intersection) were measured, so we have all the data that we need in order to find out the intermediary time.

Although it looks simple, the intermediary time method of calculation includes more factors than just the speed and distance.

In order to have the most realistic values for the time lost we have to take into account that the drivers are human. This means that they will have delays in execution of maneuvers and maybe even disturb traffic by selection of wrong lane for their moving direction. The driver will have a reaction time which is taken into consideration. Other aspects that are important are: the length of the vehicle, the acceleration of the vehicle.

The formula for the intermediary time is:

$$T_i = T_e - T_a \qquad (2)$$

Where Te is the time needed by the car that is in the space of the intersection to evacuate and Ta is the time that the car that is entering the intersection on the green time of the next phase will need to accede.

The evacuation and acceding time are calculated from the stop line to the conflict point.

The evacuation time has the following composition:

$$T_e = t + 0.5 V_e / V_a + (D_e + 1) / V_e \qquad (3)$$

In formula 3, t is the reaction time for the driver and it has a value of one second, Ve is the evacuating speed (the lowest value for the evacuation speed) and is 5.5 m/s, the acceleration a is 4.5 m/s2, De is the evacuating distance measured from the stop line to the conflict point, and l is the vehicle length, namely 6 m.

The access time, also measured from the stop line to the conflict point has a simpler formula:

$$T_a = D_a / V_a \qquad (4)$$

In formula 4, Da represents the access distance and Va the acceding speed which has the maximum legal value admitted in our case 13.9 m/s.

3. Results and Discussions

Although it looks that the formulas for the intermediary time are switched, there is a good reason for this. The most dangerous conflict situation occurs when the driver passing on the last second of green needs time to shift gears or losses time for other reasons. The acceding car into the intersection on the first seconds of green moves with the maximum legal speed and those not encounter any car at the stop line, so is not slowing down when entering the space of the intersection. So, with these formulas we will have the intermediate time for safe driving through intersection.

When the field measurements where made, the observer also noticed the trajectory of cars in the crossing of the intersection so the data in the table is based on the fact in the field.

But the reality is that the intermediary time can be greatly shortened if the drivers will move on the optimal trajectory. As presented before, the time needed to evacuate or accede depends on the distance. So, if the distance varies, the time will also vary. Taking this fact into account, we will discuss about the trajectory of vehicles, importance, and safety.

The trajectory of vehicles is determined by the driver. Many drivers do not know that one car that moves in an intersection and does not take into account that there are other traffic participants, may delay a lot of vehicles.

The intermediary time for point A1 was 2.60 seconds. But the intermediary time may vary from negative values to a value that is two times greater than the one calculated with the field data. The negative value for the intermediary time means that the cars will never meet. That implies the disappearance of the conflict point.

The implication of negative values for the intermediary time is benefic to traffic. This means that in that point no accidents will happen if the drivers move on the green light. Between that phases there will be no need for yellow time and so the green light can be longer. If we have a longer green light, there will be more cars per minute passing through that intersection, and we will realize a good traffic optimization. But in the same time, if drivers will move however they see fit, the time needed to evacuate safely for one of these situation will rise up to 4.5 seconds, time that translates into money losses, pollution increase, and noise level increase (disturbances of pedestrians and residents in the area) and this might result in traffic jams.

The traffic jam has a bigger opportunity to appear because the vehicles from different phases will enter in the same time in the space of the intersection. They will meet in the center and will have nowhere to go. This way the traffic will stop fully or partially but the delays will surely be huge.

4. Conclusions

Such intersections as the one studied are classical ones, although there are sixteen conflict points, and a big intermediary time for the size of this intersection.

The management of this type of intersection must ensure enough time such as there will be no queues on the main flow direction. In the same time, it must make sure that the integration of the secondary traffic flow in the main one is made without too many problems that can create a lot of discomfort for the majority of the drivers in the intersection.

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* E-mail address: ariadna.iliut@unitbv.ro
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