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THE STUDY OF TRAFFIC DECONGESTION IN A CROWDED INTERSECTION

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Abstract **-** This paper proposes road decongestion of Sibiu city traffic considering two options for improving an intersection. The first one consist in improving the traffic light timing for reducing the idle times and optimization of red and green times and also reducing the acoustic emission so improving the needs of an actual modern traffic. The second option consist in elimination of the traffic lights and building a new road as an alternative vehicle traffic in the eastern and south-eastern side of the city.

Keywords **-** monitoring traffic flow, traffic decongestion, conflict points, signal timing

I. INTRODUCTION

Road congestion continues to be a problem for many drivers. This results in delays to go, time lost in traffic, and accidents. It can be said that congestion reduces the quality of life for many people and therefore deserve to be addressed to improve traffic. There are many schemes for designing and implementing methods for avoiding congestion, especially in key areas [1], [2].

Various strategies are used today to increase velocity, system reliability and reduce congestion impact. These congestion management strategies can be divided into four major classes, [5]:

- Strategies aimed at improving traffic related operations;
- strategies aimed at increasing the number of people using public transport in spite of personal cars;
- strategies for modifying existing infrastructure in order to increase the capacity of roads and intersections,
- strategies to create new infrastructures .

According to the study [3] so far these strategies aim to increase the capacity of using roads. For large town that capacity will be quickly occupied, except where the available capacity building is accompanied by a complementary method such as the introduction of tolls, parking control or access management policies. Thus, even if these strategies are important and can make a singnifiante of urban traffic conditions, they are not sufficient to maintain the long-term improvements.

Brian D. Taylor in [4] suggests implementing the following strategies:

• implementation of intelligent systems that adapt to traffic conditions

• introduction of tolls in certain intervals to relieve traffic artery

• building a network that urban to facilitate and encourage public transport

• ensuring, where possible, several alternatives to reach a particular destination

• encourage multimodal transportation

Furthermore, he states that urban traffic flow is constantly evolving and so the system traffic control and monitoring should be developed and adapted continuously, [6]. In this case the method of traffic decongestion is trying to divert part of its entry / exit from Sibiu to Brasov, namely the intersection Str. Rahovei - Str. Semaforului- Calea Zarandului by the construction of a new road section.

II. INTERSECTION ANALYZE

Junction is placed in a high traffic area, both for vehicles and pedestrians. Although the intersection geometry has a well organized structure at a glance without any analysis it is observed that at peak hours the traffic capacity is exceeded, creating queues.

A. The current situation

The intersection is one intersection with traffic lights and has 4 arms two or three lanes as seen also in fig. 1, [8].

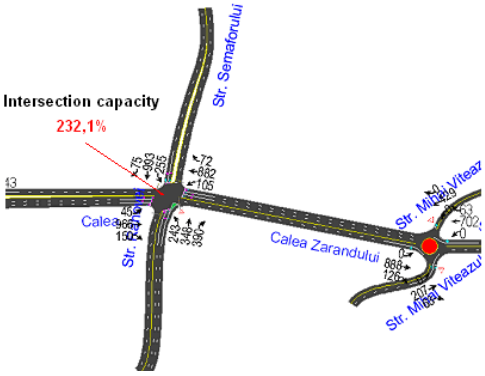

Fig. 1. Intersection geometry

Traffic light times at the intersection are presented in table I.

TABLE I
THE ORIGINAL TRAFFIC LIGHT TIMES IN THE INTERSECTION

Street	Red time (s)	Yellow time (s)	Green time (s)
Rahovei (in., stg.)	64	3	22
V Milea- to Brasov (in)	40		32
V Milea- to Brasov (stg)	75		30
Semaforului	60		20
Zarandului – to downtown (in., stg.)	40		27
Zarandului – to downtown (dr.)	44		17

Following the introduction of data collected in Synchro program, it calculated the delays for each band or group of bands and it have obtained the following values:

Str. Rahovei - phase 2

- turn left 170,5 s / h;
- forward 130,9 s / 0,1 s/h
- right turn 0,1s / h (moving under rule give way):

Calea Zarandului (direction to Brasov):

- ahead and turn left 165 s / h – phase 4;
- turn right 0 s / h (moving under rule give way);

Str. Semaforului -phase 6

- traffic light all directions 184,4 s / h

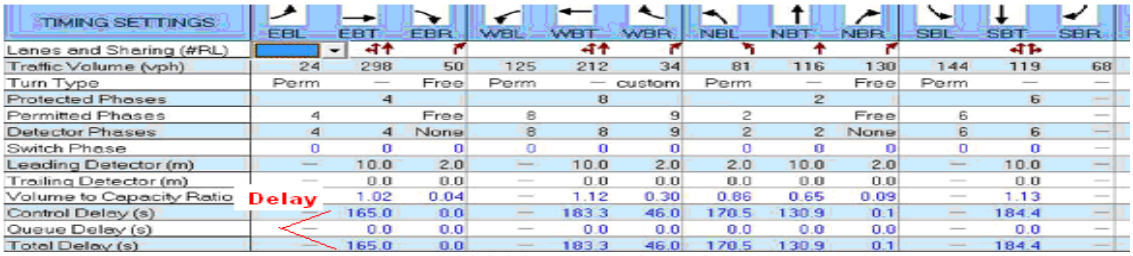

Fig. 2. Initial delays in Synchro software

Although in this case there isn't downtime, the ratio of traffic volume and intersection capacity is higher than 1, the intersection capacity utilization is exceeded.

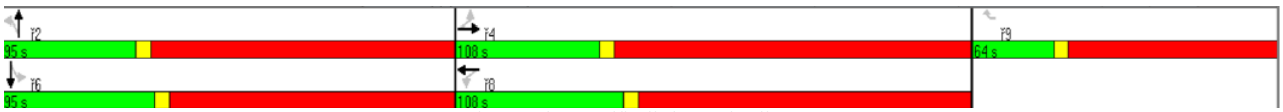

Fig. 3. First traffic light cycle diagram

By analyzing information on the intersection situation there is a maximum of the ratio vehicles volume - capacity utilization (1,13), an average delay per intersection (147,5 s / h) a total traffic light cycle (267s). By altering traffic light timing (table II) the ratio v/c is 0,74 so traffic is appropriate limits on all bands.

TABLE II
TRAFFIC LIGHT TIMES PROPOSED FOR INTERSECTION

Street	Red time (s)	Yellow time (s)	Green time (s)
Rahovei (in., left.)	55	3	43
V Milea- to Brasov (int., left)	25		80
Semaforului	45		50
Zarandului – to downtown (in., left)	30		78
Zarandului – to downtown (right)	44		18

B. Situation proposed -partial diversion of traffic

Based on the ratio output – capacity there is found that the factor that has a negative impact on traffic fluency in intersection is cycle traffic lightthat is not balanced in terms of green and red time for each maneuver.

Considering that infrastructure does not allow major changes, you can make small improvements to the intersection geometry that can have a positive impact on easing traffic flows in that area. Based on the report output - capacity is found that the factor that has a negative impact on traffic fluency is cycle traffic light intersection is not balanced in terms of green and red time for each maneuver.

Considering that infrastructure does not allow major changes, you can make small improvements to the intersection geometry that can have a positive impact on easing traffic flows in that area. As a method of reducing traffic may consider diverting part of the flow of vehicles on an alternative route.

The road will link path Zarandului (the Real store) of Str. Rahovei. Moreover, this new section of road will be an opportunity to create a path to the goal Paltinis and facilitate directing tourists towards it. It will make way for a new intersection, located at 230 m from the roundabout junction type to Brasov.

Artery obtained will have a total length of 730 + 950 = 1680 m and to be composed of four lanes, two in each direction of travel.

Artery will have over them a turn changing the direction of travel of approx. 90°. To achieve the connection there will be designed a flat curve as documentation specialist. For band widths of 3,5 m flat connection will be made with a minimum inner radius of 12,5 m, a commonly used variant being 15 m.

By introducing this new road section aims at reducing the volume of traffic on the main road that runs through downtown Sibiu, namely path Zarand - G-ral Vasile Milea Blvd.

Were taken into account as a percentage of traffic to be diverted, the following: • from 90 to 100% of the number of vehicles entering the city and left turns falling on artery Str. Rahovei • between 20-30% for left turns made to fit Dumbravii way. By a simple calculation, performed using the data collected in the field, we get a total of 405 + 152 = 557 veh / h diverted.

Fig. 4. Focused zone for the construction of a new road section

In the case streets Luptei and Nicolae Iorga is prohibited left turn maneuver, so there could not be diverted vehicles. The rest are small roads with low traffic levels (more riparians), the number of left turns made being minimal. For this reason they were not considered.

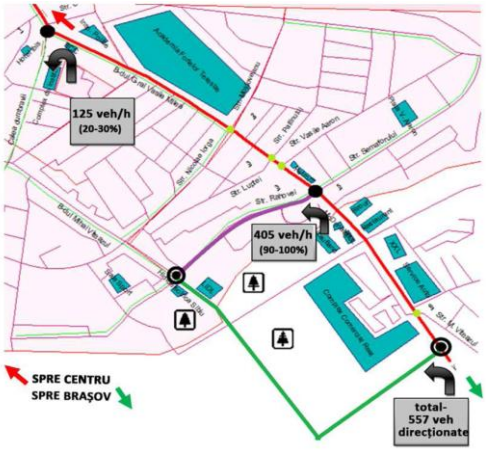

Fig. 5. The number of vehicles to be redirected on the newly road built

By building a new artery we create a T-intersection where it raise major problems regarding left turns for vehicles entering the city. The reason is that, to achieve this turn, stop mainstream vehicles leaving the city.
It creates numerous points of conflict that will slow considerably during travel, will create bottlenecks and will jeopardize the safety and security of road users.
T-intersection of two roads with two lanes creates numerous points of conflict: out of traffic flow, traffic flow input, turn left or right. The figure below illustrates the conflict points created.

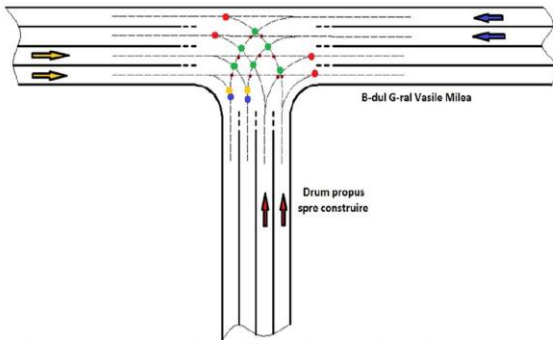

Fig. 6. Encountered conflict points at the T intersection

C. Multicriteria analysis for choice of the solution for T intersection

To find solutions for arranging the intersection it was made multicriteria analysis, which was established variants for arranging the intersection, the criteria that will influence the choice of solution and share the wheight of these criteria, [6].

There have been proposed to address the following:
1. introduction of traffic lights;
2. routing through a roundabout;
3. creating uneven intersection;
4. creating underground intersection type.

For the detection of the optimal variant an analysis will be made based on the criteria in the design of the intersection.

These are:
a) road safety;
b) flow of traffic;
c) the cost of implementing the method;
d) the method's implementation) affecting traffic (traffic disruption during construction);
f) measured by the number of conflict points (occurring after implementation method).

There are given scores for the criteria depending on the importance of one to the other as follows:
• Most importantly, is assigned the value 1;
• is equally important, is assigned the value 1/2;
• is less important, is assigned the value 0.

TABLE III
CALCULATING WEIGHT COEFFICIENT OF CRITERIA IMPORTANCE

	S	*F*	*C*	*D*	*AT*	*PC*	*Score*	*Level*	γ_i
Safety(S)	½	1	1	1	1	1	5,5	1	4,5
Flow (F)	0	½	1	1	1	½	4	2,3	2,33
Cost (C)	0	0	½	1	½	0	2	5	0,7
Time (D)	0	0	½	½	0	0	1	6	0,2
Traffic affecting (AF)	0	½	½	1	½	0	2,5	4	1,08
Nr. of conflict points (PC)	½	½	1	1	½	½	4	2,3	2

After summing the number of points for each criterion line to get one score that determines the level of importance of each criterion. Weighting coefficient is calculated using the formula Frisco:

$$\gamma_i = \frac{p + \Delta p + m + 0{,}5}{-\Delta p + \frac{N_{crt}}{2}} \quad (1)$$

where:
p - sum of points obtained for considered element
Δp - difference between the item score and score considered the last level element
m - number of surpassed criteria by criteria considered
Ncrt - number of considered criteria;
$\Delta p'$ - difference between the item score and score considered for the first element resulting in a negative.

Criteria are granted each variant one note, resulting rankings in Table IV. Highest score was obtained for variant 4 - building a subway for making left turns (105,20 points), second place, with a very close score, ranging Variant 3 - creating an uneven junctions (103,04 points).

TABLE IV
RANKING OF ANALYZED VARIANTS

		Variant 1		Variant 2		Variant 3		Varianta 4	
Criteria	γ_i	N_i	$N_i x \gamma_i$	N_i	$N_i x \gamma_i$	N_i	$N_i x \gamma_i$	N_i	$N_i x \gamma_i$
Safety(S)	4,5	8	36	7	31,5	10	45	10	45
Flow (F)	2,33	7	16,3	8	18,64	10	23,3	10	23,33
Cost (C)	0,7	9	6,3	8	5,6	7	4,9	7	4,9
Time (D)	0,2	9	1,8	7	1,4	6	1,2	6	1,2
Traffic affecting (AF)	1,08	9	9,72	5	5,4	8	8,64	10	10,8
Nr. of conflict points (PC)	2	8	16	9	18	10	20	10	20
Final ranking		*86,10*		*80,54*		*103,04*		*105,20*	

Adopt alternative 4 because the advantage that it can be done without interrupting traffic flow.

D. Design of the subway passing only for cars

Transit traffic in the city of Sibiu takes place largely on bypasses such heavy traffic does not reach the city only a small part. It is approx. 2-10% of the total traffic carried. For this reason and for reasons of cost we can consider designing an exclusive subway cars or minibuses.

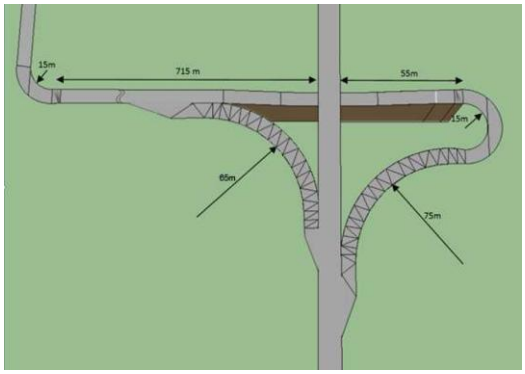

Fig. 7 The new road and intersection uneven

Following the feasibility study we concluded that the tunnel entrance will have a 55 m length to not exceed the maximum slope of 7%. This value is added to the inner radius of curvature length (15m) and width of carriageway (2 x 3,5 = 7,0 m). This reaches a width of 55 + 15 +7 = 77 m falling within the 90 m available.

Double flat connection for separation from mainstream and turnout at an angle of 90°, extends over a length of 75 + 15 + (2 x 7) = 104 m, a value that falls within the available 233 m.

Output surface is unproblematic as flat connection is made at 715 m from the exit of the passage and the land concerned is free.

III. CONCLUSIONS

The introduction of the new section of road as an alternative road to G-ral Blvd Vasile Milea lead to reduced traffic by diverting a significant percentage of the traffic. Moreover, the implementation completely eliminate uneven intersection points of conflict and therefore delays and possible accidents. It is found that the solutions successfully participate in reducing congestion in the intersection analyzed and thus the entire artery, and a combination of traffic optimization methods lead to reliable results. As a future direction, they to realize an intelligent traffic control in the area which has the role driver feedback, and data collection in order to achieve statistical reports on the number of vehicles and components for future traffic flow of traffic optimization.

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