Main Influences in Modelling and Simulation of Urban Traffic Flows

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Abstract: - Traffic modelling and simulation is an increasingly used and effective tool for analyzing a wide variety of dynamical problems which are not suitable for study by other means. This research paper presents a real application for the urban area, more precisely in Brasov city, where there was noticed some problems in the urban traffic: congestions, conflict points. The data collected for one of the busiest arterial streets of the city has represented the input data for the modelling and simulation program Synchro plus Simtraffic 6. A new solution was proposed based on the analysis of the main influences of road geometry, signalisation and traffic conditions.

Key-Words: - Traffic simulation, traffic modelling, urban mobility, road safety, traffic flows, adjustment factors.

1. Introduction

The researches performed in a very congested area of Brasov city, usually named “the big roundabout”, permitted to identify the real problems generated by the last solution for urban traffic management: traffic jams, many conflict points between vehicles and weaving of traffic flows. The map of area of interest is shown in Fig.1.

![Fig.1 The map of studied area](image)

2. Data acquisition

After a general analysis of the area in order to identify the actual situation, many activities were organised to prepare, measure and analyse the traffic flows. Thus, arrival patterns, traffic volume distribution in the entrance of each signalised or unsignalised intersection were established. The variation of traffic volumes for a representative period in a day is presented in Fig.2.

![Fig.2 Traffic volumes at Toamnei Street](image)

2.1. Evaluation of the saturation flow rate

Capacity analysis of the area can be made only after the identification of the saturation degree of each intersection.

The ideal saturation flow rate, \( S \) for the group of lanes at the entry of a signalized intersection, expressed in unitary vehicle per hour (\( V_t/h \)), is influenced by the ideal saturation flow, \( S_0 \), the number of lanes \( N \), and a very important number of adjustment factors \( f_i \) as in relation (1).

\[
S = S_0 \cdot N \cdot \prod_{i=1}^{11} f_i
\]  

Computation is based on the ideal saturation flow considered as 1900 \( V_t/h/lane \). A realistic result of
1800 Vt/h/lane is if someone consider the gap between the following vehicles are 2 seconds.

### Adjustment factors
The main influences of modelling contained by the adjustment factors, are presented in the following equations [3].

#### Lane width, W

\[ f_1 = 1 + \frac{(W - 3.5)}{9} \]  

(2)

The value 3.5 represents the standard width of a lane. The variation of the lane width from the standard 3.5 m to 4.0 m produce a variation of the adjustment factors \( f_1 \) in the 1.0 – 1.06 limits corresponding with the increase 5.6% of ideal saturation flow rate \( S \), expressed in unitary vehicle Vt/h/lane (Table 1).

<table>
<thead>
<tr>
<th>Lane width, m</th>
<th>3.5</th>
<th>3.3</th>
<th>3.2</th>
<th>3.1</th>
<th>3</th>
<th>2.8</th>
<th>2.7</th>
<th>2.6</th>
<th>2.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>( f_1 )</td>
<td>1</td>
<td>0.96</td>
<td>0.97</td>
<td>0.96</td>
<td>0.94</td>
<td>0.92</td>
<td>0.91</td>
<td>0.9</td>
<td>0.89</td>
</tr>
<tr>
<td>( S, ) Vt/h</td>
<td>1800</td>
<td>1760</td>
<td>1740</td>
<td>1720</td>
<td>1700</td>
<td>1660</td>
<td>1640</td>
<td>1620</td>
<td>1600</td>
</tr>
</tbody>
</table>

### Heavy vehicles

\[ f_2 = \frac{100}{100 + %HV(E_T - 1)} \]  

(3)

The percentage of heavy vehicles, %HV has an important influence in traffic flows. This value is between 0 – 30% and produce a variation of the adjustment factors \( f_2 \) in the limits 0.77 – 1.00 and at the same time a decrease of the ideal saturation flow rate with 23% (table 3).

<table>
<thead>
<tr>
<th>Heavy traffic, %</th>
<th>0</th>
<th>4</th>
<th>8</th>
<th>10</th>
<th>20</th>
<th>30</th>
</tr>
</thead>
<tbody>
<tr>
<td>( f_2 )</td>
<td>1</td>
<td>0.96</td>
<td>0.93</td>
<td>0.91</td>
<td>0.83</td>
<td>0.77</td>
</tr>
<tr>
<td>( S, ) Vt/h</td>
<td>1800</td>
<td>1731</td>
<td>1667</td>
<td>1636</td>
<td>1500</td>
<td>1385</td>
</tr>
</tbody>
</table>

### Bus blockage

\[ f_5 = \frac{N - \frac{14.4N_B}{3600}}{N} \]  

(6)

Where:
- \( N_B \) – number of buses stopping/h within 75 m upstream or downstream of the stop line, taking into account when the stopping buses block traffic flow in the considered lane group.

### Lane utilization

\[ f_6 = \frac{V_g}{V_{g1}} \cdot N \]  

(7)

Where:
- \( V_g \) – unadjusted demand flow rate for the lane group, expressed in vehicles per hour.
- \( V_{g1} \) – unadjusted demand flow rate on the single lane group with the highest volume.

### Left turn (LT)

The consideration of this factor takes into account the two situations. For exclusive lane:

\[ f_7 = 0.95 \]

and for shared lane:

\[ f_7 = \frac{1}{1.0 + 0.05P_{LT}} \]  

(8)

where, \( P_{LT} \) – proportion of LT, in lane group.
Right turns (RT)

For exclusive lane:
\[ f_s = 0.85 \]
for shared lane:
\[ f_s = 1 - (0.15)P_{RT} \]  \hspace{1cm} (9)
and for single lane
\[ f_s = 1 - (0.135)P_{RT} \]  \hspace{1cm} (10)
The main parameter is \( P_{RT} \), proportion of RTs in lane group.

Pedestrian – bicycle blockage

LT adjustment
\[ f_g = 1.0 - P_{LT} (1 - A_{pBT})(1 - P_{LTA}) \]  \hspace{1cm} (11)
RT adjustment
\[ f_g = 1.0 - P_{RT} (1 - A_{pBT})(1 - P_{RTA}) \]  \hspace{1cm} (12)
Where:
\( P_{LT} \) and \( P_{RT} \) – proportion of LTs and RTs in lane group,
\( A_{pBT} \) – permitted phase adjustment,
\( P_{LTA} \) and \( P_{RTA} \) – proportion of LT, respectively RT protected green over total LT green

3. Proposal for new solution

The critical analyses of modelling and simulation results permitted to formulate a new proposal.

With the proposed solution it modifies the sense of change and movement of traffic, which runs one-way only on a certain segment of the route, rest in two-way.
The traffic will be conducted by the proposed study in two directions so the volume of traffic is higher from the intersection M. Kogălniceanu - Bd November 15 - I. Maniu intersection to Bd November 15 – Toamnei Street – Zizinului Street – Calea București. With the implementation of this solution, two factors have remained unresolved: the noise and possible points of conflict pedestrian - vehicle and vehicle-vehicle.

The intersection named B-dul Hărmanului –Toamnei Street – B-dul M. Kogălniceanu is an intersection with three branches and two accesses (Toamnei Street, and B-dul M. Kogălniceanu).
The proposed intersection scheme will have an actuated control type. This actuated control type would require installation of inductive loops and connecting them to a central unit. Another change is that the intersection will have 3 accesses and on Toamnei Street will come back in two-way traffic.

Benefits of the actuated control type:
- Increase the capacity of movement
- Reduce delays
- Allows synchronization of the signalized programs

Access to the intersection will be done according to the request in this way advantaging the main traffic flows.

In the study we had made one of the following problems had been identified in the intersection:

- queues that form on the Toamnei Street
Conflict points of vehicle-vehicle appeared in traffic flows between the two accesses of the intersection (B-dul Harmanului and Toamnei Street) as you can see in Fig.6.

3 Simulation
In the following are presented comparative graphs between the actual situation and the proposed one: speed of movement, fuel consumption, stops/vehicle and delays.
Stops occur in areas where traffic flows are intersecting and traffic volumes are high. The crossing of traffic flow generally occurs at the exit or entry into intersection, when most drivers try to get on a lane on which to continue their movement towards the next intersection. Some vehicles will be forced to stop in order to fit in lane that they wish to continue their movement.

Delays are caused by conflicts of the pedestrian with vehicles, arising in particular for vehicles that made a right turn onto B-dul Hărmanului from Toamnei Street.

4. Conclusions
Thus the proposed solution reflected the results from the actual situation regarding: time delays generated by the vehicle stops, fuel consumption efficiency, the formation of queues, reducing the conflict points. Even a doubling of existing traffic volumes, has not created large queues.

References: