CAR AND PEDESTRIAN: CONFLICT CROSSING POINTS

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ABSTRACT

The intensity of traffic and pedestrian flows in the streets of Russian cities, in particular, Tambov, are studied. Conflict points before and after the introduction of bus lanes are considered. Graphs of transport flow intensity are shown with a division into modes of transport, pedestrian flow intensity graph, and composition of a traffic flow as well as conflict points of the most complex intersections with a high coefficient of conflict.

Keywords: car, public transport, pedestrian flows, bus lanes, intersection, traffic intensity, safety, conflict points, route passenger transport.

Background. *In recent decades, there has been an increase in the vehicle fleet of the country. For this reason, there is an increase in city saturation with road transport, which in turn leads to a change in the whole nature of traffic.*

Objective. *The objective of the authors is to study conflict points, which arise at the intersections.*

Methods. *The authors use general scientific methods, simulation, statistical approach.*

Results.

Priority of bus lanes

At peak hours traffic intensity on separate highways of most cities reaches the limit, and the capacity of the road network elements reduces as much as possible.

With the growth of cities and their territories increase the distance and number of trips. Volume of freight and passenger traffic increases. And hence we can observe the increase in the number of traffic flows, deterioration of effectiveness of vehicles' use, vehicle speed decreases. Reducing the speed of transport because of inactivity near intersections leads to increased levels of noise, increase in the gas content of the city air basin and overspending of fuel and lubricants.

The traffic problem in modern cities turns into a major urban planning and management task. The level of urban redevelopment depends on its right solution [1]. Particular attention gets traffic organization, passenger transport routes.

The aim of this study is to optimize urban traffic by giving a priority to route passenger transport, improving route network and its arrangement, reducing to a minimum the time spent by passengers in transit. These problems, in our opinion, can be solved primarily in the presence of bus lanes for route public transport.

Firstly, the number of conflict points at intersections reduces; secondly, speed of route passenger transport increases; thirdly, the introduction of advanced technologies in the field of vehicular traffic is possible, including through the introduction of the experience of other cities with similar problems.

In cities of Russia dominates traditional historical layout of streets – radial and mixed. To get from one area to another, it is necessary to drive through the main streets, often turn to the right or to the left. Often people go through the city to work or study. All this causes traffic congestion, prevent residents from normal use of stopping points of passenger routes.

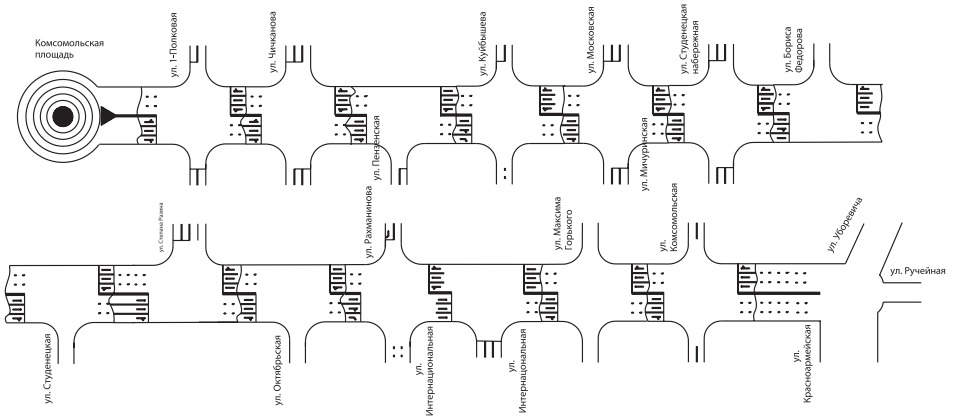
Often drivers violate traffic rules and leave their cars on a roadway or bus stops. Because of this route vehicles have to stop for embarkation and disembarkation of passengers in the second and sometimes third lanes. At the time of embarkation / disembarkation a roadway narrows and stops traffic flows.

Congestion or traffic jam is the accumulation of vehicles traveling at an average speed, which is much lower than the normal speed for a given road section. In forming the congestion bandwidth of the route reduces significantly (up to 20 times or more). If inbound traffic flow exceeds the capacity of the route section, the congestion is growing like an avalanche [4].

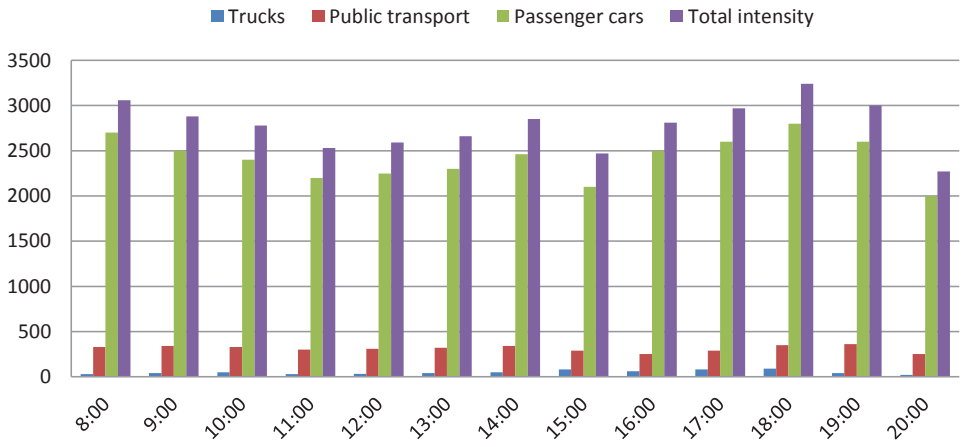
Because of this, of course, there are an increase in travel time, delays, increased fuel consumption, vehicle wear and tear, unpredictability, stress of drivers, passengers, an increase in accidents and as a result – economic damage.

Foreign precedents

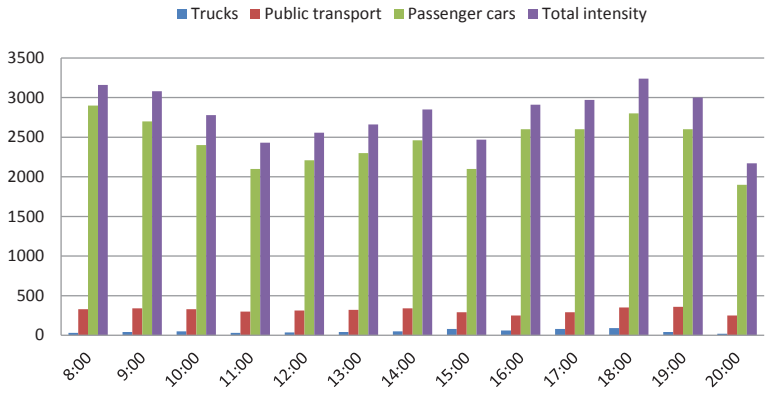
Largely indicated problem can be solved by the introduction of a traffic priority to route passenger transport on stretches and at controlled intersections. In addition, the implementation of the priority of pas-



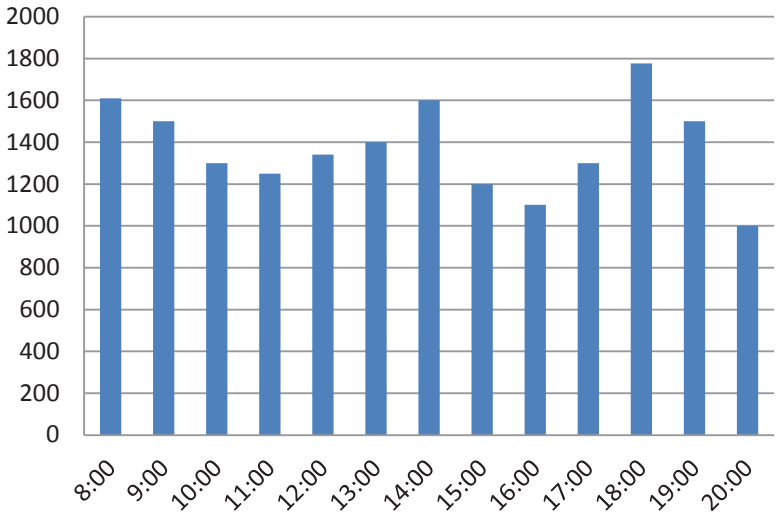
Pic. 1. Sovetskaya street.



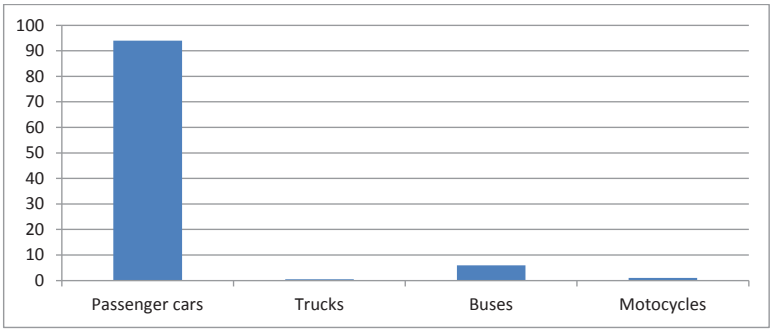
Pic. 2. The graph of transport flow intensity from the south direction, broken down by modes of transport.



Pic. 3. The graph of transport flow intensity from the north direction, broken down by modes of transport.



Pic. 4. Pedestrian flow intensity.



Pic. 5. Composition of transport flow, %.

Table 1

Pedestrian flow intensity

Pedestrian flow intensity, people/10 min	296
Pedestrian flow intensity, people/h	1776

senger transport may be the most expedient way to improve the functioning of the road network in the economic aspect.

Practice of other countries shows that the most effective method for organization of route passenger transport is the allocation of special lanes, on which the movement of other vehicles is prohibited.

Bus lanes for urban route passenger transport are almost everywhere, except for Africa and Southeast Asia.

Bus lanes for the first time appeared in the US in 1940.

Bus lanes solve tasks such as acceleration of public transport, control of chaotic parking, traffic safety (when placing the lane at the center line), increase in the attractiveness of public transport for the population, i.e. the priority of public transport.

In most cases bus lanes are allocated in the rightmost lane.

But there are several options for bus lanes for route passenger transport:

1. You can make a bus lane from the rightmost lane in the direction of flow. Advantage is simplicity. The disadvantages are difficulties in emergency situations, poor protection against violations of the lane mode, the delay due to the right turns.

2. You can make a bus lane from the rightmost lane, but in the direction opposite to flow. The advantage of this option is high protection from violations of the lane mode. Disadvantages include traffic delays because of the complex traffic organization, the need to build a divider for stops.

3. You can make a bus lane in both directions near the center line of the street. Advantages: no delays in the right turns, safety. Disadvantages: capital intensity, the problem of chaotic parking remains.

In Vancouver, the allocation of special lanes on major routes has given the following effect:

– Reduction of travel time by 3-10 minutes during the peak period and by 10-12 minutes – in off-peak;

– Increase in the speed of buses by 23-29%;

– Increase in the number of transported passengers by 25-30% [2].

In Moscow, according to the Department of transport and development of road transport infrastructure of the city, the speed of buses in bus lanes on average increased by 30%, passenger traffic – by 15% [3].

There are conditions under which the allocation of separate lanes is recommended:

– Roadway of the street in one direction has at least three lanes;

– The current intensity of traffic flow of this direction (reduced to one lane) is in peak periods not less than 400 units / h;

– The traffic intensity of buses (trolley buses) of a large class is at least 50 units/ h, and articulated vehicles are taken as two units. [7].

Usually for route vehicles the rightmost lane in the direction of travel is pointed with markings with the permission of the right turns for the car from a bus lane.

Left-side Tambov

Given the amount of violations of prohibition signs of stopping and parking, as well as the growth of car ownership in the foreseeable future for the Russian cities lanes of priority motion and bus lanes (with a resolution of movement of vehicles on them in a particular case) are ineffective. In most cases, the effect of their implementation is equivalent to the action of signs «No parking» or «No stop». To organize traffic control on the lane and to ensure the smooth movement of route passenger transport in congestion situation can only be done with a total ban on the movement of vehicles on the lanes for route passenger transport and subject to close monitoring by the traffic police authorities.

Due to these reasons it is advisable to consider the separate lanes, on which in contrast to the priority lanes only the movement of route passenger transport is allowed.

This project proposes to introduce bus lanes only for route passenger vehicles on the far left lanes.

Let's consider this task in more detail on the example of the central street of the average in the Russian Federation, the city of Tambov.

Sovetskaya street is not a high-speed highway (see. The government resolution № 767 from 28.09.2009 «On the classification of roads in the Russian Federation») [6].

The oldest and the main street of the city, it plays an important role in solving internal transport problems, located in the area of economic development. Its characteristics:

– Road category – main street of district level;

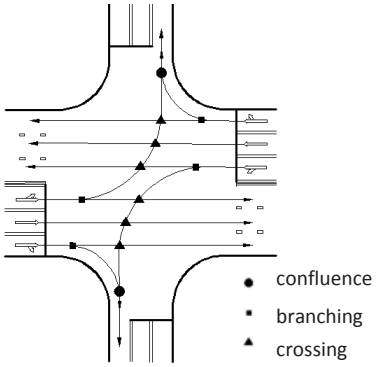
– The estimated speed – 60 km / h;

– Number of lanes – 6;

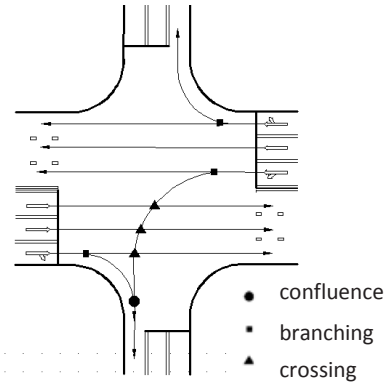
– Lane width – 3,5 m;

– The width of the roadway – 21 m.

To determine the characteristics of the motion



Pic. 6. Conflict points of the intersection.



Pic. 7. Conflict points of the intersection.

data were collected characterizing traffic flow: traffic intensity, the composition of flow, traffic delays.

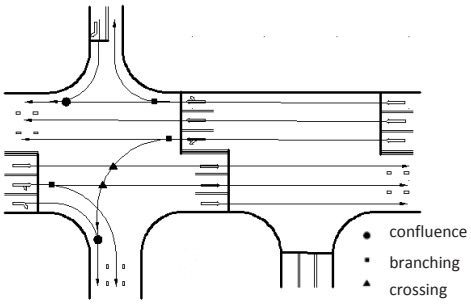
Note that the intensity of the traffic flow (traffic intensity) Na is a number of vehicles passing through the section of road per unit time. The composition of transport flow is the relation therein of various types of vehicles. Traffic delays are indicators that should be paid special attention to in the evaluation of the state of the road traffic. We refer to the delay time loss not only for all forced stops of vehicles in front of intersections, railway crossings, at traffic jams on stretches, but also due to reducing the rate of traffic flow as compared to the current average speed of free movement on the road section [7, pp. 22-31].

Pedestrian alternative

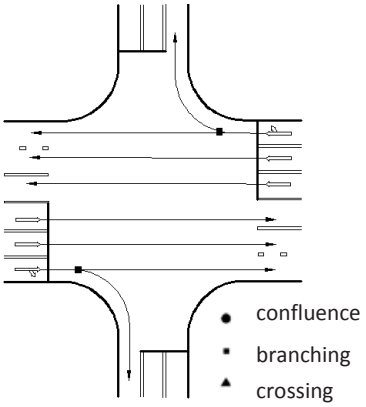
The study of transport and pedestrian flows was conducted in autumn during the day from 8-00 to 20-00 hours. The observations were carried out in different weekdays (during peak hours), as well as on weekends.

The studies provided data on the intensity of transport and pedestrian flows (with division into modes of transport, taking into account the daily non-uniformity and weekly fluctuations).

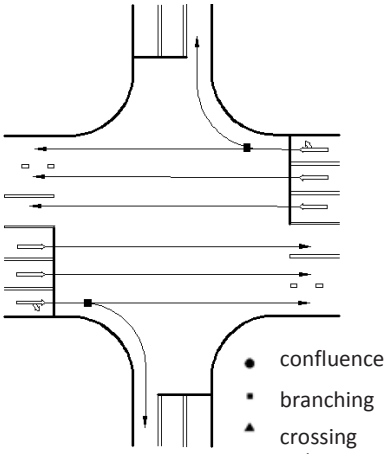
The intensity of the traffic during the day varies slightly (Pic. 2 and 3). Transport flow is uniform throughout the day, there is a greater intensity in the evening. In the evening rush hour from the south (st. Dynamo), the total traffic intensity is 1692 cars / h, from the north – 1612 cars / h. In the morning rush hour for the south direction the total traffic intensity is 1682 cars / h, for the north direction – 1382 cars/ h. The highest intensity on the road network is observed in the morning and evening peak hours.



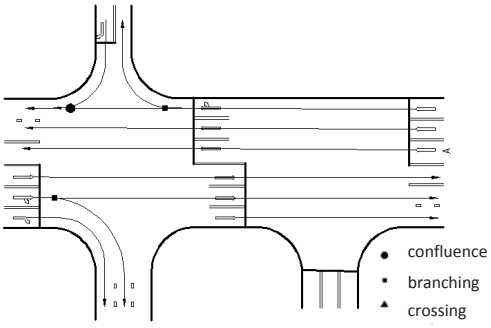
Pic. 8. Conflict points of the intersection.



Pic. 9. Conflict points of the intersection.



Pic. 10. Conflict points of the intersection.



Pic. 11. Conflict points of the intersection.

The intensity of pedestrian flow N_{ped} (number of pedestrians passing through a certain cross-section of the path at a time unit) depends on the functional purpose of the road and attraction objects located on it. Sovetskaya Street is the main traffic artery of the city, it is located a large number of people's attraction facilities is located on it (offices, retail outlets, places of culture and leisure).

Pic. 4 and Table 1 show pedestrian flow intensity.

Pic. 5 illustrates the structure of the transport flow, from which it follows that the number of passenger cars is much higher than the number of route passenger transport. Passenger transport creates significant difficulties for passenger routes.

Points of street conflicts

Next, we examine conflict points of the most difficult street intersections of streets: Sovetskaya–Chichkanova, Sovetskaya–Moscovskaya–Michurinskaya, Sovetskaya–Internationalnaya–Rachmaninova.

Given the traffic intensity, the index of conflict is determined by the formula [5]:

$$m = 0,01 \cdot \left[1\sum_{i=1}^{n_0} N_{0i} + 3\sum_{i=1}^{n_c} N_{ci} + 5\sum_{i=1}^{n_n} N_{ni} \right], \qquad (1)$$

where n_0, n_c, n_n are numbers of points of branching, confluence and crossing; N_{oi}, N_{ci}, N_{ni} are smaller intensities of each pair of transport flows conflicting with each other.

Then we apply the formula to different intersections determining level of complexity.

Intersection Sovetskaya–Chichkanova streets (Pic. 6).

n_0=4; n_c=2; n_n=6, hence:

m=0,01 • [(180+60+212+65)+3(360+316)+5(280+280+280+302+302+302)]=112,7.

At 150>m>80 the intersection is complex.

Intersection Sovetskaya–Moscovskaya–Michurinskaya streets (Pic. 7).

n_0=3; n_c=1; n_n=3, hence:

m=0,01 • [(160+148+235)+3(260)+5(200+200+200)]=43.

At 80>m>40 the intersection is of average complexity.

The intersection Sovetskaya–Internationalnaya–S.Rakhmaninova streets (Pic. 8).

n_0=3; n_c=2; n_n=2, hence:

m=0,01 • [(400+150+510)+3(430+240)+5(250+250)]=56.

At 80>m>40 the intersection is of average complexity.

Conflict loading of the intersection with bus lanes changes the situation.

The intersection Sovetskaya–Chichkanova streets (Pic. 9).

n_0=2; n_c=0; n_n=0, hence:

m=0,01 • [(180+212)]=4.

At m<40 the intersection is simple.

The intersection Sovetskaya–Moskovskaya–Michurinskaya streets (Pic. 10).

n_0=2; n_c=0; n_n=0, hence:

m=0,01 • [(160+235)]=4.

At m<40 the intersection is simple.

The intersection Sovetskaya–Internationalnaya–S.Rakhmaninova (Pic. 11).

n_0=2; n_c=1; n_n=0, hence:

m=0,01 • [(400+150+510)+3(430+240)+5(250+250)]=56.

At 80>m>40 the intersection is of average complexity.

Conclusions.

1. The intensity of transport flows during the day varies slightly. The flow is uniform, high intensity is observed in the evening.

2. The greatest load of the road network is observed in the morning and evening peak hours.

3. Intensity of pedestrian flow during the day varies slightly, the largest intensity is observed in the morning, lunch and evening peak hours.

4. The number of passenger cars is much higher than the number of route passenger transport. Passenger transportat creates significant difficulties for traffic on the routes of public transport.

5. When allocating lanes for passenger lines the number of conflict points reduces, and therefore, the movement will be more safe.

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