OPTIMIZATION OF TRANSPORTATION ON URBAN PASSENGER LINES

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ABSTRACT

The objective of the work is to optimize urban transportation by giving priority to route passenger transport, including by using bus lanes. Methods of study are full-scale observations, statistics, and reporting. Improvement of traffic management can increase safety level, reduce a number of conflict points, increase carrying capacity and speed of communication, ensure application of advanced technologies in the system of vehicle movement regulation. The article continues reports on researches conducted by the authors in the town of Tambov (see World of Transport and Transportation, Vol. 13, 2015, Iss. 3 and 5).

Keywords: bus, trolleybus, bus lanes, route passenger transport, traffic management, carrying capacity, speed of communication.

Background. *With an increase in traffic intensity on city roads the task of improving speed and safety of route passenger transport is particularly vital and yet hard-to-be-solved. At a minimum, it is required to give certain advantages for route buses and trolley buses. Such advantages are provided by relevant provisions of the traffic regulations of the Russian Federation, GOST 10807–78 and GOST 23457–86, including the introduction of a special phase in the cycle of traffic lights control at the intersections, separate limitations for other vehicles in the public transport route, allocation of a special lane for movement of route passenger transport, access to which is prohibited for other types of vehicles [1–3].*

As mentioned in previous articles [6, 7], recently increase in the vehicle fleet of the country has been observed. Because of this, there is an increase in saturation of cities with road transport, which in turn results in a change in the entire nature of road traffic, over-loading of the road network. Route passenger transport is particularly affected by this, because the majority of the population uses it.

We have in the course of the project, we recall, investigated and analyzed the existing scheme of traffic organization in the average city of the Russian Federation, on an example of the street Sovetskaya of Tambov, made a comparative analysis of accidents by region and particular street, studied composition and intensity of traffic flow, features of route passenger transport, assessed carrying capacity of the road, loading and delays of vehicles.

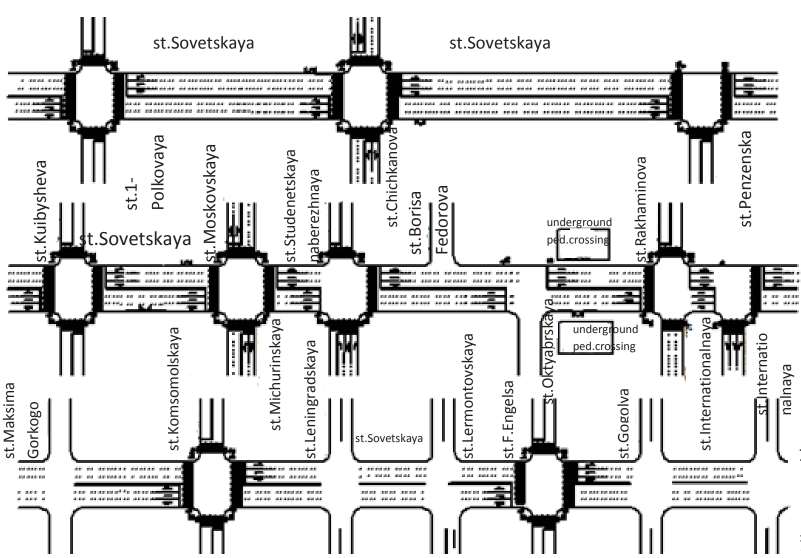
Objective. *The objective of the authors is to consider possible optimization of transportation on urban passenger lines at the example of Tambov city by changing location of separate bus lanes.*

Methods. *The authors use general scientific methods, full-scale observations, comparative analysis, evaluation approach, simulation, statistical analysis.*

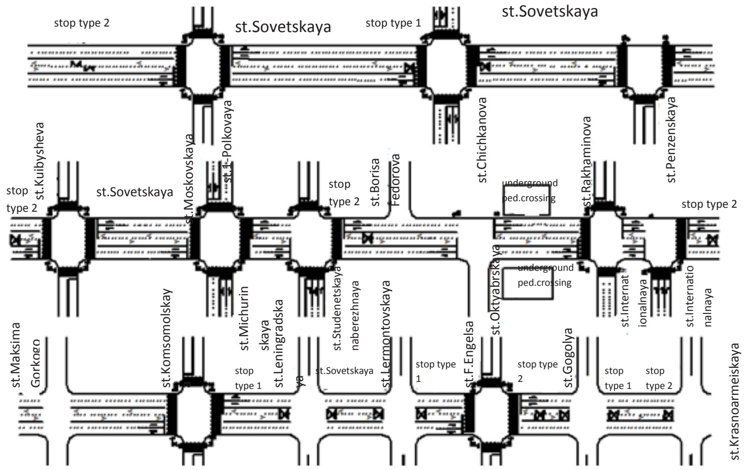
Results. *According to the analysis a conclusion was drawn on effectiveness of introduction of extreme left bus lanes for route passenger transport. During calculations we recorded a significant reduction in traffic delays and time loss of passengers en route, reduction of the number of conflict points, which entails a reduction in the number of road accidents, the number of victims, as well as of negative impact of transport vehicles on the environment.*

Sovetskaya street does not belong to high-speed roads, if we take as a basis grading, set by Government Decree of the Russian Federation № 767 of 28.09.2009 «On classification of roads in the Russian Federation» [2].

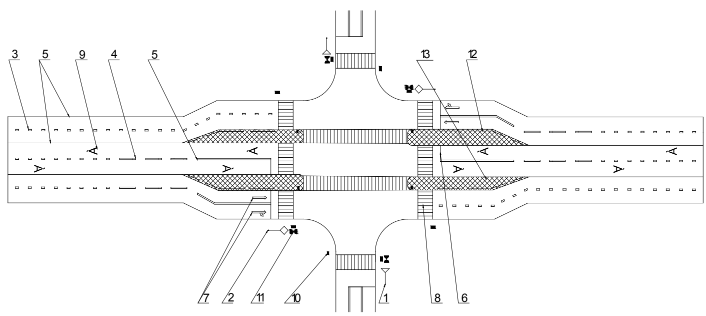
The oldest and the main street of the city plays an important role in solving problems associated with traffic management and creation of some optimal design schemes. Therefore, first of all its general characteristics were taken into account (Pic. 1):



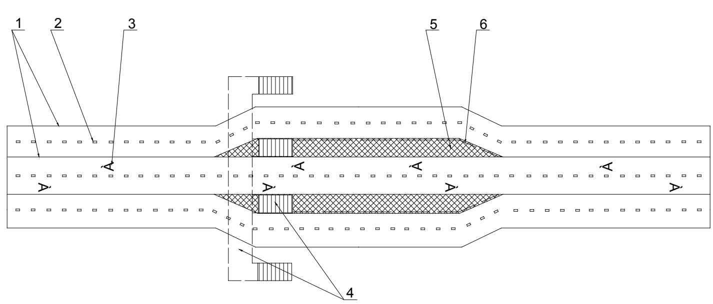
Pic. 1. Existing scheme of traffic management.



Pic. 2. Optimizing traffic management scheme.



Pic. 3. A stop of the first type: 1 – sign 2.4 «Give way»; 2 – sign 2.1 «Main road»; 3 – horizontal markings 1.5 «Broken line»; 4 – horizontal markings 1.6 «Approaching stop line»; 5 – horizontal markings 1.1 «Designation of lanes»; 6 – horizontal marking 1.12 «Stop-line»; 7 – horizontal markings 1.18 «Flow direction arrows»; 8 – horizontal markings 1.14.1 «Pedestrian crossing», 9 – horizontal markings 1.23.1 «Special lane for route vehicles»; 10 – traffic light P. 1 «Pedestrian»; 11 – traffic light T.1 «Transport three-sectional»; 12 – pedestrian fencing; 13– traffic island.



Pic. 4. A stop of the second type: 1 – horizontal markings 1.1 «Designation of lanes»; 2 – horizontal markings 1.5 «Broken line»; 3 – horizontal markings 1.23.1 «Special lane for route vehicles»; 4 – underground pedestrian crossing; 5 – traffic island; 6 – pedestrian fencing.

- *Category – main street of regional significance;*
- *Estimated speed – 60 km / h;*
- *Number of lanes – 6;*
- *Width of the lane – 3,5 m;*
- *Width of the roadway – 21 m.*

Taking into account the known characteristics a diagram of traffic reorganization is built (Pic. 2).

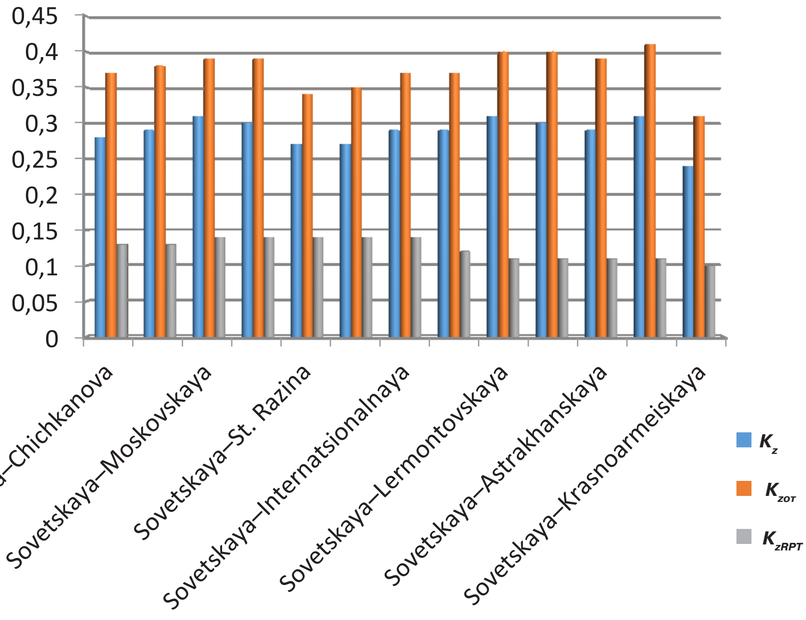
The project proposes to introduce bus lanes for route passenger transport along the street Sovetskaya from Komsomolskaya square to the stop «Dinamo Stadium» at extreme left lanes of a roadway. To separate a bus lane markings type 1.1. (solid marking line) is provided [1]. It was decided to abandon fencing. Firstly, in case of a traffic accident or an emergency stop of the car, the bus movement will be «paralyzed». Secondly, in case of road repair options to bypass obstacles are required. Thirdly, installation of fencing requires a significant expansion of the roadway, that is impossible.

On approaches to intersections where right turn of passenger transport is desired (e. g. routes № 32, № 5 at the crossroads of Sovetskaya street – Moskovskaya street, routes № 52, № 18, at the intersection with the street Internationalnaya, routes

Table 1

Indicators of load of crossings to allocate a left lane for route passenger transport

Name of the intersection	Number of approach	N, u. / h.	Number of lanes	M, u. / h.	K_z
1. Sovetskaya–Chichkanova	1	1590	3	1837,5	0,28
	2	1610	3	1837,5	0,29
	3	453	2	2100	0,11
	4	439	2	2100	0,10
2. Sovetskaya–Moskovskaya–Michurinskaya	1	1692	3	1837,5	0,31
	2	1682	3	1837,5	0,30
	3	318	2	1707	0,09
	4	540	2	1925	0,14
3. Sovetskaya–St. Razina	1	1523	3	1837,5	0,27
	2	1516	3	1837,5	0,27
	3	1230	2	1837,5	0,34
4. Sovetskaya–Internationalnaya–S. Rakhmaninova	1	1603	3	1837,5	0,29
	2	1586	3	1837,5	0,29
	3	1442	3	1837,5	0,26
	4	425	1	1050	0,41
5. Sovetskaya–Lermontovskaya	1	1686	3	1837,5	0,31
	2	1674	3	1837,5	0,30
	3	614	2	1837,5	0,17
	4	180	2	1312,5	0,07
6. Sovetskaya–Astrakhanskaya	1	1650	3	1837,5	0,29
	2	1700	3	1837,5	0,31
	3	900	2	1837,5	0,25
	4	119	1	1575	0,08
7. Sovetskaya–Krasnoarmeyskaya–Uborevicha	1	1313	3	1837,5	0,24
	2	412	1	1575	0,26
	3	1250	2	1837,5	0,34
	4	681	1	1575	0,43



Pic. 5. The diagram comparing load factors: K_z – total load coefficient, K_{zOT} – load coefficient for passenger cars, K_{zRPT} – load coefficient for route passenger transport.

Table 2

Indicators of intersections' load with bus lanes for route passenger transport

Name of intersection	Number of approach	$N_{red'}$, u./h.		Number of lanes		M, u./h.	K_{zRPT}	K_{zOT}
		RPT	Other transport	Bus lanes	Other lanes			
1. Sovetskaya–Chichkanova	1	230	1360	1	2	1837,5	0,13	0,37
	2	230	1380	1	2	1837,5	0,13	0,38
	3	–	453	–	2	2100	–	0,11
	4	–	439	–	2	2100	–	0,10
2. Sovetskaya–Moskovskaya–Michurinskaya	1	250	1442	1	2	1837,5	0,14	0,39
	2	250	1432	1	2	1837,5	0,14	0,39
	3	–	318	–	2	1707	–	0,09
	4	–	540	–	2	1925	–	0,14
3. Sovetskaya–St. Razina	1	250	1237	1	2	1837,5	0,14	0,34
	2	250	1266	1	2	1837,5	0,14	0,35
	3	–	1230	–	2	1837,5	–	0,34
4. Sovetskaya–Internationalnaya–S. Rakhmaninova	1	250	1353	1	2	1837,5	0,14	0,37
	2	220	1366	1	2	1837,5	0,12	0,37
	3	–	1442	–	3	1837,5	–	0,26
	4	–	425	–	1	1050	–	0,41
5. Sovetskaya–Lermontovskaya	1	200	1486	1	2	1837,5	0,11	0,40
	2	200	1474	1	2	1837,5	0,11	0,40
	3	–	614	–	2	1837,5	–	0,17
	4	–	180	–	2	1312,5	–	0,07
6. Sovetskaya–Astrakhanskaya	1	200	1450	1	2	1837,5	0,11	0,39
	2	200	1500	1	2	1837,5	0,11	0,41
	3	–	900	–	2	1837,5	–	0,25
	4	–	119	–	1	1575	–	0,08
7. Sovetskaya–Krasnoarmeyskaya–Uborevicha	1	180	1133	1	2	1837,5	0,10	0,31
	2	–	412	–	1	1575	–	0,26
	3	–	1250	–	2	1837,5	–	0,34
	4	–	681	–	1	1575	–	0,43

№ 55, № 50 – st. Pionerskaya), it is proposed to use markings 1.11 [1].

It is planned to have stops for route passenger transport of two types.

Type 1: stop on the approach and at the exit from the intersection (Pic. 3.).

Four traffic islands, equipped with fencing, are provided. Fencing is needed for pedestrians do not cross the roadway in the wrong places. Route passenger transport will make a stop on a bus lane near the traffic island. It is proposed to connect traffic islands with each other using marking line 1.14.1 («zebra»). This will help pedestrians to freely select a desired bus. Additional traffic lights will be installed on the islands, separating transport and pedestrian flows. The length of the traffic island is 25 m, width is 3,5 m. The number of stops of this type is four.

Type 2: stop for route transport with underground pedestrian crossing.

The length of the traffic island is 35 m, width is 3,5 m. Embarkation and disembarkation of passengers is focused on traffic islands, equipped with fencing. Pedestrians will use an underground crossing to approach stop. The number of stops of this type is seven.

Then we carry out a comparative analysis of load factors with the existing and the proposed traffic schemes.

From Table 1 it follows that flow distribution is uniform. The most loaded intersections are 4 and 7, and they have a significant impact on the movement of vehicles along the street Sovetskaya.

$K_{zji\ max}$ and $K_{Zji\ min}$ are respectively maximum and minimum values of coefficients of load on the entire road network, $K_{zji\ max} = 0,4$; $K_{zji\ min} = 0,1$.

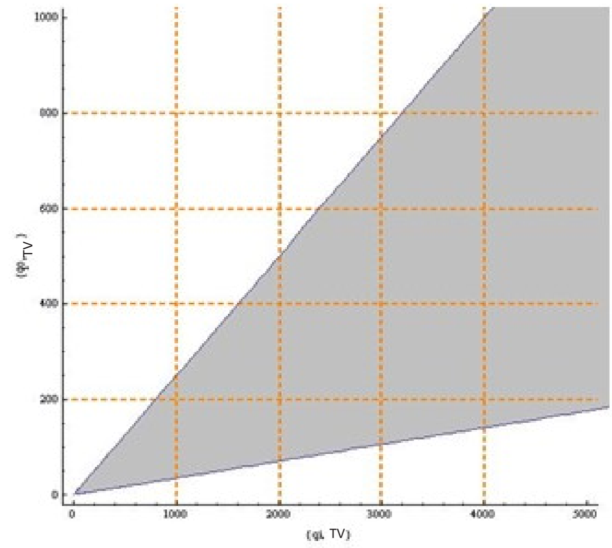
Therefore, we can conclude that the flow distribution is uniform. The load coefficients will decrease. Their value indicates that vehicles are moving on the lanes freely (Pic. 5).

The diagram shows that traffic congestion significantly increases for passenger cars, but the movement of route passenger transport route facilitates greatly.

Separately, in a project the relevance of introduction of bus lanes is considered.

Pic. 6 shows a nomogram. Using it, we can determine for which traffic intensity of public and private transport it is advisable to allocate lanes for route passenger transport. According to the data presented it is easy to see that allocation of bus lane will reduce the overall delay time for all traffic participants at the considered section [4, 5].

With the initial data on intensity of traffic flow, it is possible to check in which field is located a point on the graph with given values of initial parameters N_i, N_o and subsequently determine the feasibility of



Pic. 6. The nomogram: q_0 – intensity of movement of route passenger transport, q_i – intensity of movement of passenger cars.

allocation in this area of the network of a lane for public transport.

Calculations of effectiveness of the proposed project suggest that the payback period of investments when fulfilling specified conditions occurs in the second year after the optimization scheme takes effect.

Conclusions. *According to the analysis made in the article, we can see the effectiveness of introduction of extreme left bus lanes for route passenger transportation in such an average statistical city as Tambov.*

Calculation of proposed schemes of rational organization of traffic in the urban passenger lines has been made in view of the current traffic situation on the object under consideration and the existing intensity of traffic flows.

The caluclated results have shown a significant reduction in traffic delays and time loss of passengers en route, reduction of a number of conflict points, which entails a reduction in the number of accidents, number of victims, as well as the negative impact of transport vehicles on the environment.

It is possible to use the recommendations of this project for a detailed review of design of traffic organization of route passenger transport on the streets of any city in Russia, although this assumes, of course, taking into account local conditions and specific additional requirements.

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