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CAPACITY INCREASING OF ARTERIAL STREETS WITH CONTROLLED MOTION

Summary. *The problem of capacity increasing of arterial streets with controlled motion is investigated in this paper. For investigation, sections between intersections on the road network of Lviv city were chosen at their different length and roadway width with most saturated traffic. Methods of capacity increasing of arterial streets with controlled motion and factors that have impact on the capacity reduction are analyzed. Capacity of intersections at different volume-capacity ratios is determined. The distribution of average speed for sections between intersections of different length is built. It is established that on sections of medium length between signalized intersections and the high volume-capacity ratio, the speed of traffic flow does not reach maximum values. It is possible to increase the speed and the capacity of sections between intersections by increasing their length, sufficient for flow acceleration to the maximal constant speed and further braking before the intersection. To determinate the recommended speed of movement on arterial directions, road conditions are taken into account, which are formed with simultaneous impact of several factors: volume-capacity ratio of intersection in braking zone, volume-capacity ratio of intersection in acceleration zone, the number of lanes, the length of the section between intersections and the average speed of the traffic flow. It is determined that the average speed of traffic flow on short sections between intersections (the length less than 300 m) is 27–33 km/h, on sections of medium length – 35–38 km/h/ Such speed will allow to traffic flow reaching the line of constant movement in given road conditions. Conducted research allows taking into account road traffic conditions while justifying the calculating speed of traffic flow, in result of which capacity of arterial streets of controlled motion increases.*

Key words: *road network, traffic flow, traffic intensity, speed of movement, capacity, volume-capacity ratio, traffic simulation, field research, signalized intersections.*

1. INTRODUCTION

The problem of capacity increasing of arterial streets and increasing of vehicles` speed of movement acquired national scales and its solution belongs to priorities of social and economic policy of the state. Increasing of motorization level by 7–13 % per year leads to the reduction of average speed of traffic flow by 10–25 km/h, fuel consumption increased by 25–30 %, every year the number of road accidents increases, and the ecology is worsens.

Capacity belongs to the main indicators that characterize conditions of urban streets and roads operation. A minimal value of certain cross-section, to which at-grade signalized intersection belong, takes as streets` capacity. At-grade intersections` capacity largely determines the productivity of the whole transport system of the city, level of comfort and transportation safety.

2. RESEARCH STATEMENT

Short sections between intersections on the road network, their loading by the movement, unsatisfactory road pavement do not allow providing the high speed of traffic flow. Provision of the length of the sections between signalized intersections that is sufficient for acceleration to the maximal speed of the flow in given road conditions allows increasing the capacity of road network.

Capacity increasing of arterial streets of controlled motion is necessary not only for improvement of movement conditions but also for increasing the economy and comfort of the whole traffic flow.

3. RELEVANCE OF THE STUDY

With the increasing of motorization level and volume-capacity ratio, the average speed of movement of traffic flow decreases. The current situation causes the reduction of the quality and reliability of transport systems functioning in large cities, decreasing the effectiveness of operation of all city services. In conditions of budget deficit, a task of capacity increasing of arterial streets in shortest terms with minimal costs becomes especially relevant. To increase the capacity of arterial streets, it is necessary to carry out experimental research by the main characteristics of traffic flow.

4. AIM AND THE TASK OF THE RESEARCH

The main aim of the publication is capacity increasing of arterial streets with controlled motion. For this aim, it is necessary to carry out the research on the speed regime of traffic flow on sections between intersections on the road network at their different length and roadway width.

To reach the aim, such tasks are formulated:

- to analyze the methods of signalized intersection capacity determination;
- to carry out field research on the change of traffic flow speed on sections between intersections of arterial streets;
- to develop recommendations about capacity increasing of arterial streets.

5. ANALYSIS OF RECENT RESEARCH AND PUBLICATIONS

Effective traffic management of the road network plays a significant role in safety of the person that is on the roadway. Due to the requirements of national standards in the sphere of traffic management, a conflict of traffic and pedestrian flows in one phase of traffic light control is not allowed [1–5]. However, the regime of traffic light operation with separate pedestrian phase foresees the increasing of waiting time of the green signal both for vehicles and for pedestrians, in addition, intersection capacity decreases.

Capacity of streets with controlled motion is maximal value of traffic intensity in one direction on road section [6–8]. It (capacity) is one of the main parameters that characterize movement conditions of traffic flow. If at-grade signalized intersections are present on the section of the street, the estimation of capacity determines with consideration of intersection capacity before the stop-line. The reduction of the duration of signalized intersections passage allows improving the movement conditions on the street, increasing its capacity, hence, capacity of the whole road network [7].

Many researchers put forward such hypothesis during the determination of capacity of roadway lane:

- vehicles that pass the intersection can delay before the traffic light, which takes place in practice during the movement of dense traffic flows with the total usage of roadway capacity [9–10].
- after turning on the permissive signal of traffic light, the speed of vehicles which start to pass the intersection and temporary intervals between them are the same, independently from the dynamic features of vehicles. Based on this, to calculate the capacity of one lane, such formula is used [1, 3–6, 11–12]:

$$N_{p.c.u.} = \frac{3600(t_g - a)}{\delta t \cdot T_c}, \tag{1}$$

where t_g – duration of green phase of traffic light, sec; a – delay of vehicles at the start, sec; δt – average interval of vehicle movement through the stop-line, sec; T_c – traffic light cycle duration, sec.

In view of the peculiarities of traffic management and control on signalized intersections, we can highlight few typical cases for the calculation of arterial capacity in cross-section of stop-line: calculation of capacity for X-shaped and T-shaped intersections.

Let us view five cases of capacity calculation for X-shaped intersection:

1 case. There is one lane in the cross-section of stop-line. All movement directions are allowed in one general phase, turn flows herewith create obstacles for the next straight flow. Arterial capacity in the cross-section of stop-line (P) determines by formula [1, 2, 5, 13–14]:

$$P = \eta \cdot N_{p.c.u.}, \tag{2}$$

where η – coefficient that lowers the capacity at the expence of obstacles from the left-turn flow and depends on the share of the left turn $\eta = f(a)$ (for $\eta=2$, $a=0$; $\eta=1.65$, $a=10$; $\eta=1.6$, $a=20$; $\eta=1.55$, $a=30$; $\eta=1.50$, $a=40$).

2 case. There are two and more lanes in the cross-section of stop-line, control is carried out without additional sections, and all movement directions are allowed in one general green phase. Indicators of directions distribution on the lanes are absent. In this case, roadway capacity determines by formula [1, 2, 5, 13–14]:

$$P = \eta_l \cdot N_{p.c.u.}(n-1), \tag{3}$$

where n – number of lanes in the cross-section of stop-line; η_l – coefficient that considers capacity of left-turn lane [1, 2, 5, 13–14]:

$$\eta_l = \frac{N + N_l}{N}, \tag{4}$$

where N – general number of vehicles in the cross-section of stop-line per hour, p.c.u./h; N_l – number of vehicles in the cross-section that make left turn per hour, p.c.u./h.

3 case. There are two and more lanes in the cross-section of stop-line. The control is carried out without additional sections, and all movement directions are allowed in one general phase. Two outer lanes are for the turn movement, straight flows move from one or two inner lanes. The calculation of capacity os carried out by the formula [1, 2, 5, 13–14]:

$$P = \eta_r \cdot N_{p.c.u.}(n-1), \tag{5}$$

where η_r – coefficient that considers capacity of turn lanes [1, 2, 5, 13–14]:

$$\eta_l = \frac{N + N_l + N_r}{N}, \tag{6}$$

where N_r – number of vehicles in the cross-section that make right turn per hour, p.c.u./h.

4 case. There are three and more lanes in the cross-section of stop-line. Control at the intersection is three- or four-phased with additions sections. Left outer lane is for the passage of left-turn flow. Straight and right-turn flow pass with the main green signal of traffic light t_g, left-turn flows pass in the additional phase. Roadway capacity calculates by formula [1, 2, 5, 13–14]:

$$P = P_1 + P_2, \tag{7}$$

where P_1 – capacity of right-turn lanes, p.c.u./h; P_2 – capacity of straight and left-turn lanes, p.c.u/h.

$$P_1 = N_{p.c.u.}(n-1), \tag{8}$$

$$P_2 = \frac{3600(t_g - a)}{\delta t \cdot T_c}. \tag{9}$$

5 case. There is one lane in the cross-section of stop-line. Control is with sequential passage of vehicles from every street or from separate direction. Capacity in conditions of full division of traffic and pedestrian flows determines by the capacity of one lane and the number of lanes by formula (1).

Capacity for T-shaped intersections determines, depending on the number of phases in every traffic light cycle:

1 case. The passage of traffic and pedestrians flows is carried out in two phases (Fig. 1):

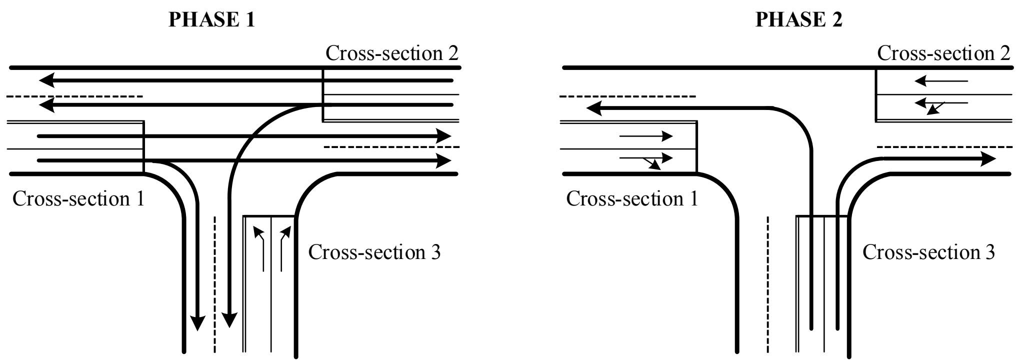

Fig. 1. Distribution of traffic flows of different directions by lanes and phases of traffic light control

Roadway capacity:

− in cross-sections 1 and 3 determines by formula [1, 2, 5, 13–14]:

$$P = N_{p.c.u.} \cdot n_r, \tag{10}$$

− in cross-section 2 :

$$P = N_{p.c.u.} \cdot \eta. \tag{11}$$

2 case. The passage of traffic and pedestrian flows is carried out in three phases (Fig. 2):

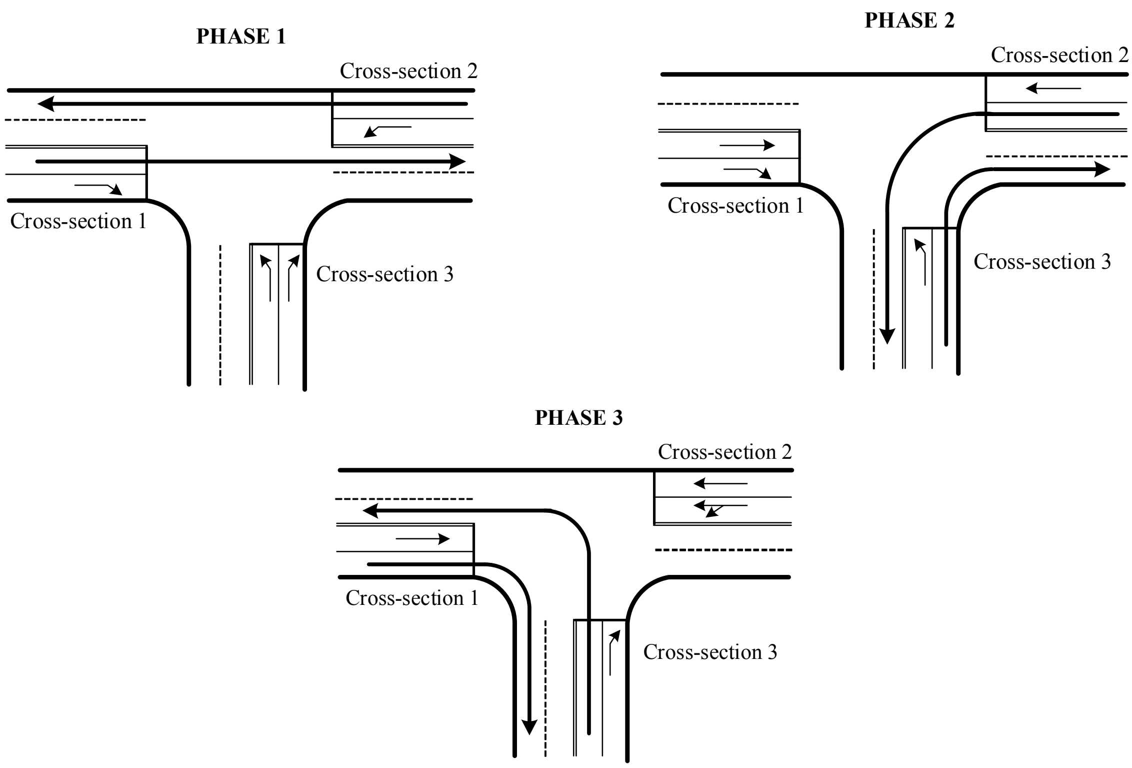

Fig. 2. Distribution of traffic flows of different directions by lanes and phases of traffic light control

Roadway capacity:

− in cross-section 1 determines by formula [1, 2, 5, 13–14]:

$$P = P_3 + P_1, \tag{12}$$

− in cross-section 2:

$$P = P_3 + P_2, \tag{13}$$

- in cross-section 3:

$$P = P_1 + P_3, \tag{14}$$

where P_1 – capacity of right-turn lanes; P_2 – capacity of left-turn lanes; P_3 – capacity of straight lanes.

$$P_3 = N_{p.c.u.} \cdot n. \tag{15}$$

Improvement of conditions of vehicles passage through the signalized intersections on arterial streets in conditions of dense traffic flow is possible with implementation of optimized traffic light cycle and effective use of existing road network.

6. PRESENTATION OF THE MAIN MATERIAL

To optimize the traffic movement on arterial streets of Lviv city, research on the speed regime of traffic flow was carried out on the sections between intersections on the road network with their different length and different roadway width.

The capacity of separate sections of roads measures to determine the opportunity to pass columns of vehicles, to obtain additional coefficients of capacity reduction, and to estimate the effectiveness of the measures concerning capacity increasing. Investigation was carried out on sections between intersections on the arterial streets of Lviv city.

The first investigated object – Stryiska Str. Two sections between intersections are reviewed between Stryiska – V. Velykoho Str. and Stryiska – Naukova – Khutorivka intersections (Fig. 3):

- the first section is limited by Stryiska – V. Velykoho Str. and Stryiska – Rubchaka Str. intersections;
- the second section is limited by Stryiska – Rubchaka Str. and Stryiska – Naukova – Khutorivka Str. intersections.

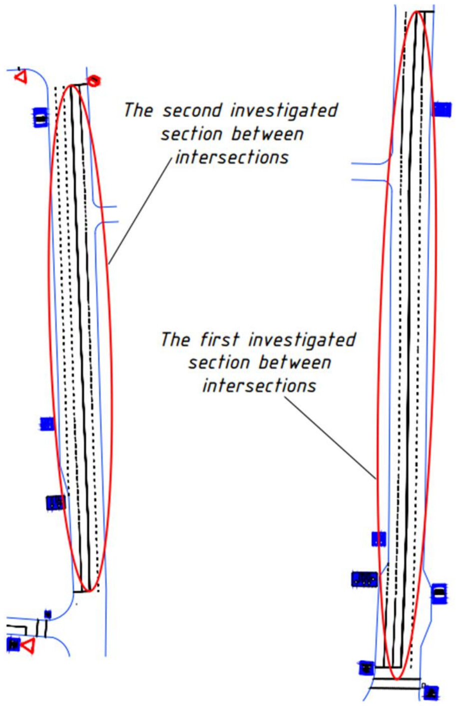

Fig. 3. The map of Lviv city territory, Stryiska Str.
(from V. Velykoho Str. to Naukova – Khutorivka Str.)

The road pavement on the investigated section of two-lane arterial street Stryiska is asphalt-concrete. The length of the first section is 300 m, the second – 400 m.

The second investigated object is V. Velykoho Str. Three sections between intersections are reviewed between V. Velykoho – Aivazovskoho Str. and V. Velykoho – Symonenka Str. intersections (Fig. 4):

- the first section is limited by V. Velykoho – Aivazovskoho Str. intersection and signalized pedestrian crosswalk on V. Velykoho Str.;
- the second section is limited by signalized pedestrian crosswalk on V. Velykoho Str. and V. Velykoho – Botkina Str. intersection;
- the third section is limited by controlled intersections of V. Velykoho – Botkina Str. and V. Velykoho – Symonenka Str.

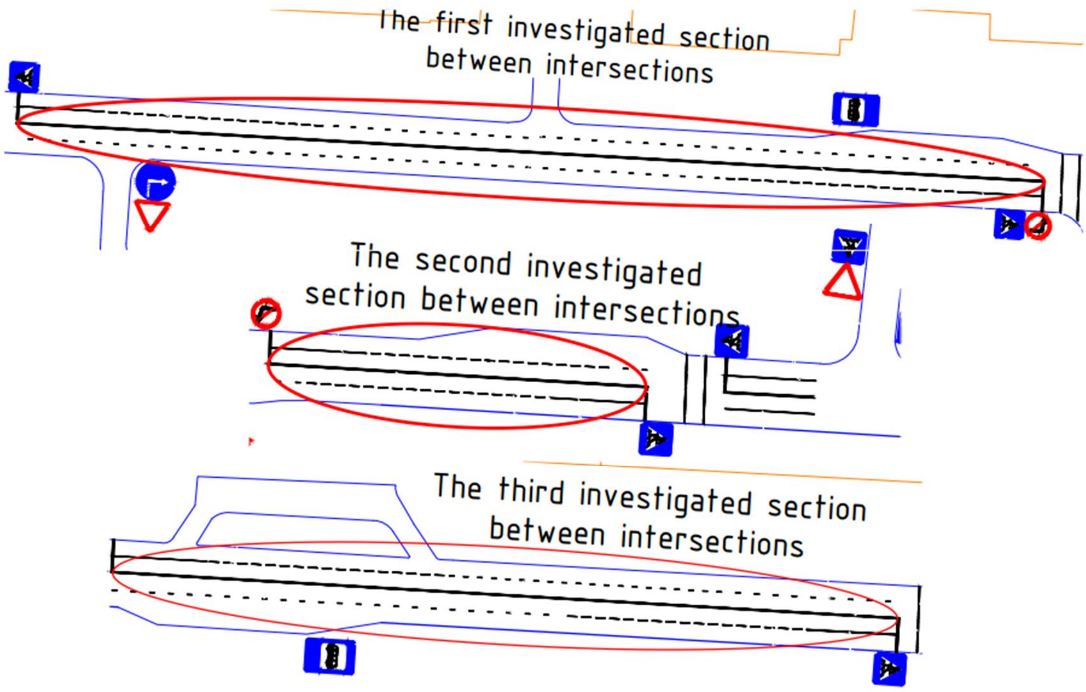

Fig. 4. The map of Lviv city territory, V. Velykoho Str. (from Aivazovskoho Str. to Symonenka Str.)

The road pavement on the investigated section of two-lane arterial street V. Velykoho is asphalt-concrete. The length of the first section is 290 m, the second – 100 m, and the third – 200 m.

The third investigated object is Horodotska Str. Three sections between intersections are reviewed between Horodotska– Vyhovskoho Str. and Horodotska – Riashivska Str. intersections (Fig. 5):

- the first section is limited by Horodotska– Vyhovskoho Str. intersection and signalized pedestrian crosswalk on Horodotska Str.;
- the second section is limited by signalized pedestrian crosswalk on Horodotska Str. and Horodotska – Sambirska – Velychka Str. intersection;
- the third section is limited by controlled intersections of Horodotska – Sambirska – Velychka Str. and Horodotska – Riashivska Str.

The road pavement on the investigated section of two-lane arterial street Horodotska is asphalt-concrete. The length of the first section is 200 m, the second – 500 m, and the third – 400 m.

During the determination of arterial streets capacity, the investigation of regimes of traffic movement was carried out with the help of video recording. Instantaneous velocities of vehicles, travel time, traffic intensity and composition, roadway width, and dynamic gauge of vehicles were recorded.

To determine the capacity of signalized intersections, field research was carried out in peak periods: from 7:00 to 8:00 in the morning and from 16:30 to 17:30 in the evening in the weekday. For the calculation of capacity at the cross-section of stop-line, investigated objects are divided on X-shaped and T-shaped. During the investigation, intersections of Stryiska – V. Velykoho Str., Stryiska – Rubchaka Str., Stryiska – Naukova – Khutorivka Str., V. Velykoho – Aivazovskoho Str., signalized pedestrian crosswalk on V. Velykoho Str., intersections of V. Velykoho – Botkina Str., V. Velykoho – Symonenka Str., Horodotska – Vyhovskoho Str., signalized pedestrian crosswalk on Horodotska Str., intersections of Horodotska – Sambirska – Velychka Str., Horodotska – Riashivska Str.

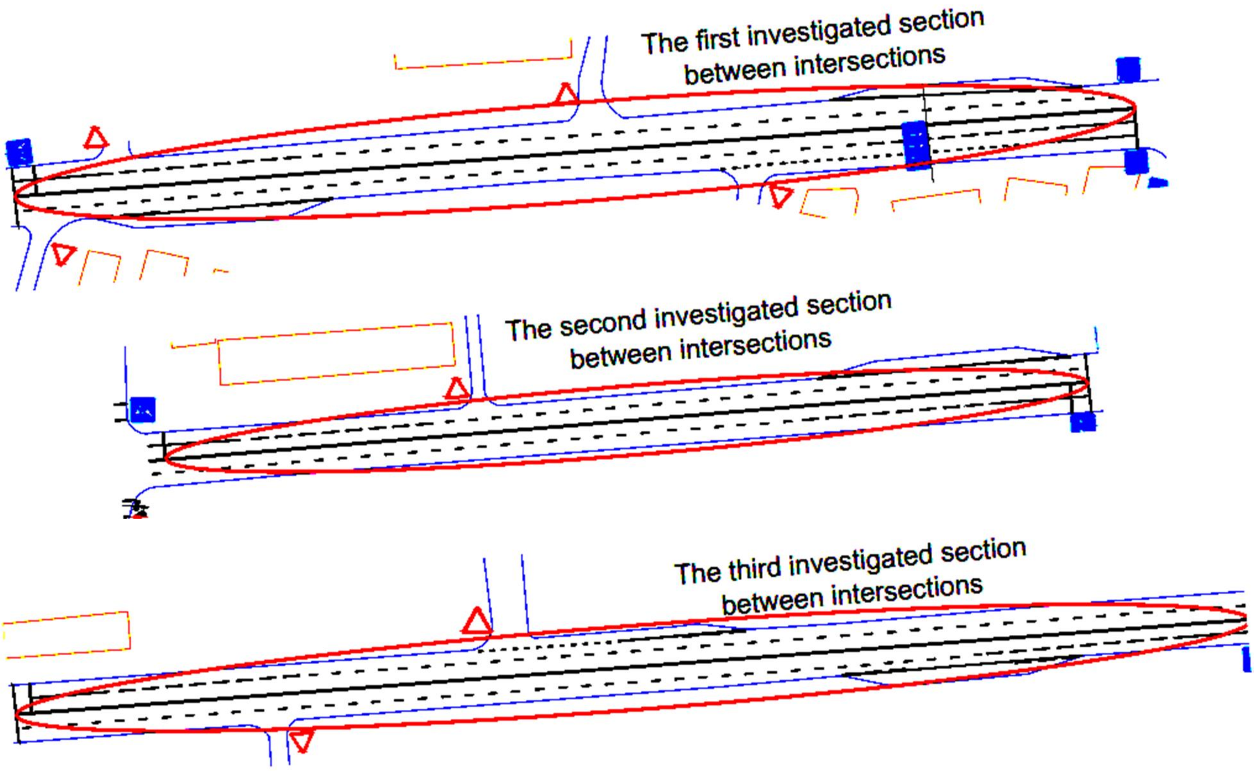

Fig. 5. The map of Lviv city territory, Horodotska St (from Vyhovskoho Str. to Riashivska Str.)

The phased scheme of traffic management at X-shaped intersection of V. Velykoho – Aivazovskoho Str. is given on Fig. 6.

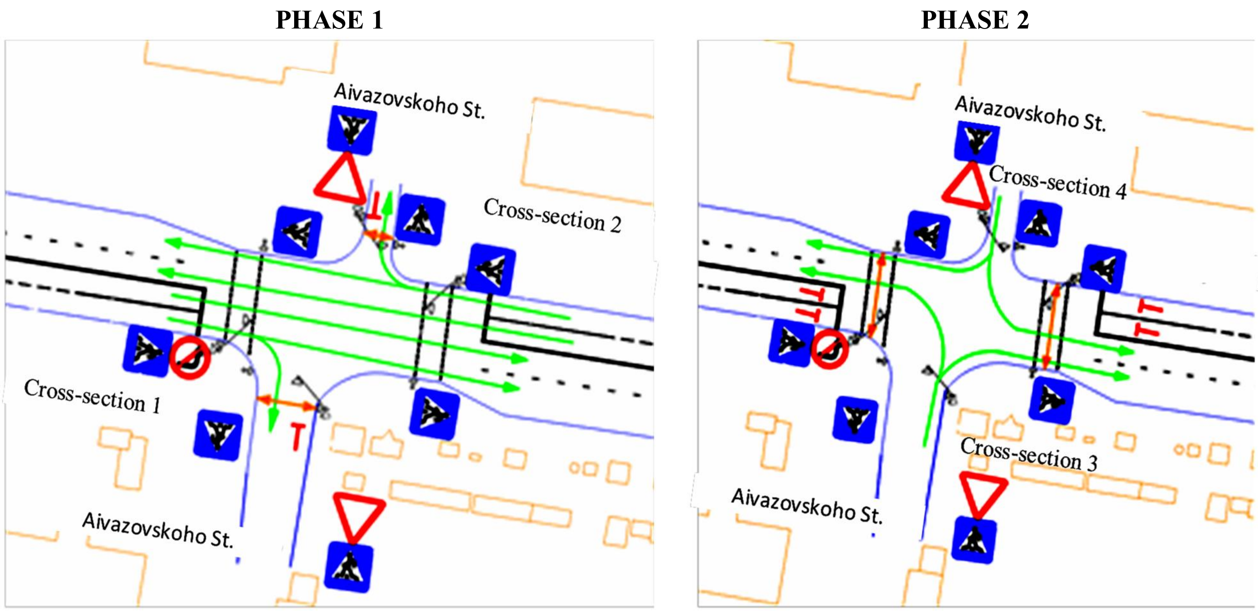

Fig. 6. Phased scheme of traffic management at X-shaped intersection of V. Velykoho – Aivazovskoho Str.

To determine the capacity in cross-section of stop-line, such output data is needed:

1) Traffic flow intensity:

- cross-section 1: straight – 1149 p.c.u./h; right – 159 p.c.u./h.
- cross-section 2: straight – 1212 p.c.u./h; left – 88 p.c.u./h; right – 126 p.c.u./h.
- cross-section 3: straight – 96 p.c.u./h; left – 121 p.c.u./h; right – 94 p.c.u./h
- cross-section 4: straight – 139 p.c.u./h; left – 101 p.c.u./h; right – 83 p.c.u./h.

2) A number of roadway lanes in cross-section of stop-lines: cross-section 1 – 2 lanes; cross-section 2 – 2 lanes; cross-section 3 – 1 lane; cross-section 4 – 1 lane.

3) Traffic light control regime and traffic management scheme by phases (Fig. 6).

Traffic light control is carried out in two phases with cycle duration:

$$Tc = 48 + 3 + 16 + 3 = 70 \text{ sec}$$

Capacity in cross-section of stop-line at X-shaped intersection of V. Velykoho – Aivazovskoho Str.

$$P_{\text{cross-section1}} = 1.65 \cdot 1308 = 2158 \text{ p.c.u./h},$$

- cross-section 2 (formula (2)):

$$P_{\text{cross-section2}} = 1.65 \cdot 426 = 2353 \text{ p.c.u./h},$$

- cross-section 3 (formula (5)):

$$P_{\text{cross-section3}} = \frac{94 + 96 + 121}{94} \cdot \frac{3600 \cdot (16 - 2)}{3 \cdot 70} = 794 \text{ p.c.u./h},$$

- cross-section 4 (formula (5)):

$$P_{\text{cross-section4}} = \frac{83 + 101 + 139}{83} \cdot \frac{3600 \cdot (16 - 2)}{3 \cdot 70} = 934 \text{ p.c.u./h}.$$

Capacity of total X-shaped intersection of V. Velykoho – Aivazovskoho Str. is:

$$P_{\text{cross-section4}} = P_{\text{cross-section1}} + P_{\text{cross-section2}} + P_{\text{cross-section3}} + P_{\text{cross-section4}} =$$
$$= 2158 + 2353 + 794 + 934 = 6239 \; p.c.u./h.$$

Using formulas (1)–(15), we carried out the calculation of capacity on investigated objects, and their results are given in Table 1.

Table 1

Evaluation of capacity of investigated objects

Name of intersection	General intensity of traffic flow at intersection, p.c.u./h	Capacity of intersection, p.c.u./h	Volume-capacity ratio
V. Velykoho – Aivazovskoho Str.	3368	6239	0.54
Signalized pedestrian crosswalk on V. Velykoho Str.	3575	5290	0.68
V. Velykoho – Botkina Str.	2910	5442	0.53
V. Velykoho – Symonenka Str.	2938	5587	0.53
Horodotska – Riashivska Str.	4095	6300	0.65
Horodotska – Sambirska – Velychka Str.	4716	7145	0.66
Signalized pedestrian crosswalk on Horodotska Str.	4241	6316	0.67
Horodotska – Vyhovskoho Str.	3576	6622	0.54
Stryiska – V. Velykoho Str.	4486	6597	0.68
Stryiska – Rubchaka Str	3681	5334	0.69
Stryiska – Naukova – Khutorivka Str.	4977	7110	0.70

From the results of conducted investigation, we can say that the highest volume-capacity ratio is at the intersection of Stryiska – Naukova – Khutorivka Str. and it is 0.70. As a result, transport delays increase. To improve the operation of intersections on arterial streets, it is necessary to carry out the estimation of speed regimes of traffic flows.

A development of measures concerning capacity increase is necessary to carry out based on the estimation of speed regimes of traffic flows. It will allow determining and reducing the impact of road conditions on road network capacity.

To determine the average speed of movement on every section between intersections, it is necessary to carry out the measurements of the average travel time. Herewith, the average speed determines by the range of conditions: a number of lanes, road pavement evenness, traffic flow intensity and composition, the presence of descents and ascents, the length of section between intersections, etc.

Research was carried out during the daylight with volume-capacity ratio on sections between intersections 0.3–0.8 on sections without significant deformations of road pavement. Work was carried out on sections that are characterized by: different length (short sections to 300 m, middle sections – 300–700 m, long sections – more than 700 m), different comfort level, with no less than 35 passages in forward and reverse directions.

By results of conducted research, three characteristic zones of the change of traffic flow speed are disclosed on sections between intersections: zone of acceleration after intersection, zone of braking before intersection and zone of constant speed (Fig. 7).

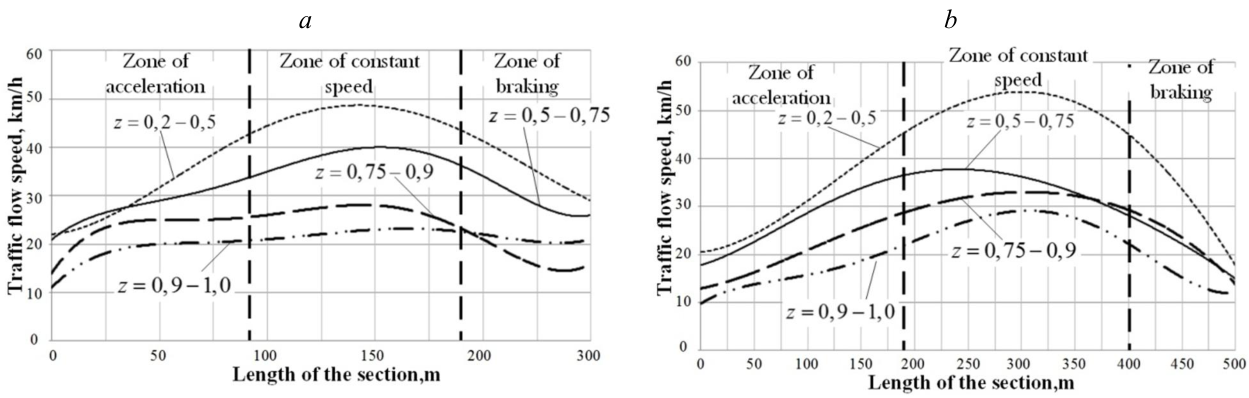

Fig. 7. Graph of the change of traffic flow speed: a – short-length sections between intersections to 300 m; b – middle-length sections between intersections 300–700 m

On short-length sections between intersections (Fig. 7, *a*), in conditions of impositions of influence zones of adjacent intersections, sections with constant speed are absent. Change of traffic flow speed on short sections between intersections depends on the volume-capacity ratio of intersections.

On middle-length sections between intersections (Fig. 7. *b*) that operate in regime of saturated flow movement, at sufficient capacity of adjacent intersections, road sections with constant speed of traffic flow are observed.

Statistical processing of obtained data with the help of program Excel allowed obtaining the dependence of the impact of the length of section between intersections (L_s) and volume-capacity ratio (z) on the constant speed of movement of traffic flow (Table 2).

On the short-length sections between intersections, the maneuver for bypass the road pavement defects is limited, roadway condition has impact on the constant speed of traffic flow (coefficient of determination is 0.77–0.89). On the middle-length sections between signalized intersections and high volume-capacity ratio, traffic flow speed does not reach its maximal values. The speed and capacity of sections between intersections can be increased by increasing their length that will be sufficient for acceleration of the flow to the maximal constant speed and further braking before the intersection.

Table 2

Dependencies of impact of the length of sections between intersections and volume-capacity ratio on traffic flow speed

Volume-capacity ratio	Formulas	Coefficient of determination, R^2	Number of formula
Short-length sections between intersections			
0.2–0.5	$V_c = 0.38L_s^4 - 5.69L_s^3 + 26.29L_s^2 - 34.92L_s + 36$	0.89	16
0.5–0.75	$V_c = 0.17L_s^4 - 2.61L_s^3 + 11.75L_s^2 - 12.19L_s + 24$	0.83	17
0.75–0.9	$V_c = 0.13L_s^4 - 0.28L_s^3 - 4.92L_s^2 + 22.81L_s - 4$	0.81	18
0.9–1.0	$V_c = 0.13L_s^4 + 2.01L_s^3 - 12.1L_s^2 + 32.63L_s - 11$	0.77	19
Middle-length sections between intersections			
0.2–0.5	$V_c = 0.013L_s^4 - 0.49L_s^3 + 4.2L_s^2 - 5.57L_s + 22.3$	0.88	20
0.5–0.75	$V_c = 0,011L_s^4 - 0,27L_s^3 + 1,39L_s^2 + 3,19L_s + 13,2$	0.80	21
0.75–0.9	$V_c = 0.001L_s^4 - 0.11L_s^3 + 0.89L_s^2 + 1.88L_s + 10.9$	0.76	22
0.9–1.0	$V_c = 0.015L_s^4 - 0.43L_s^3 + 3.56L_s^2 - 6.84L_s + 14.5$	0.70	23

On sections between intersections that operate in regime of traffic jam, where precisely expressed zones of the change of traffic flow speed are absent, vehicles queues are observed, the length of which is longer than the length of corresponding sections between intersections. The speed herewith does not exceed 20 km/h. In such conditions, intersections do not cope with the passage of traffic flow.

By results of processing of the results of fields research (Fig. 7) of the change of traffic flow speed depending on the length of sections between intersections, the distribution of the average speed of traffic flow for every zone (zone of acceleration, zone of constant speed, zone of braking) is built (Fig. 8–9).

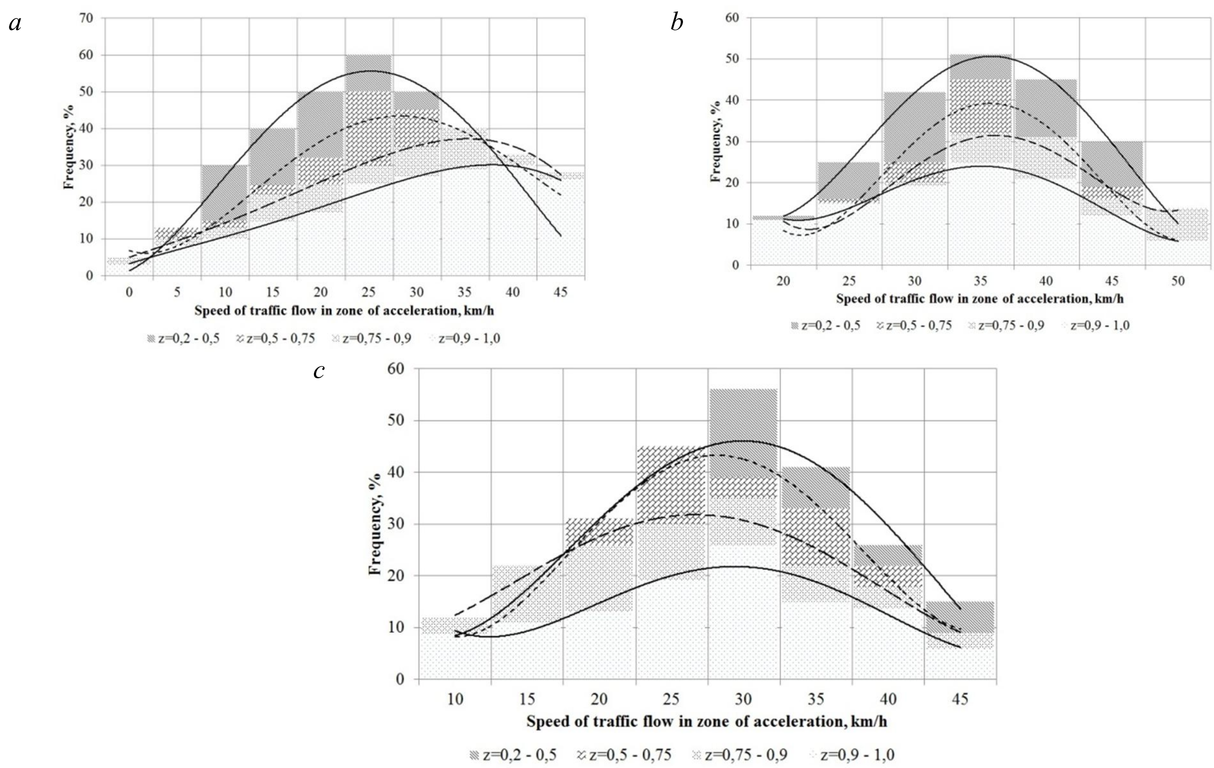

Fig. 8. Distribution of average speed for short sections between intersections to 300 m: a – for zone of acceleration; b – for zone of constant speed; c – for zone of braking

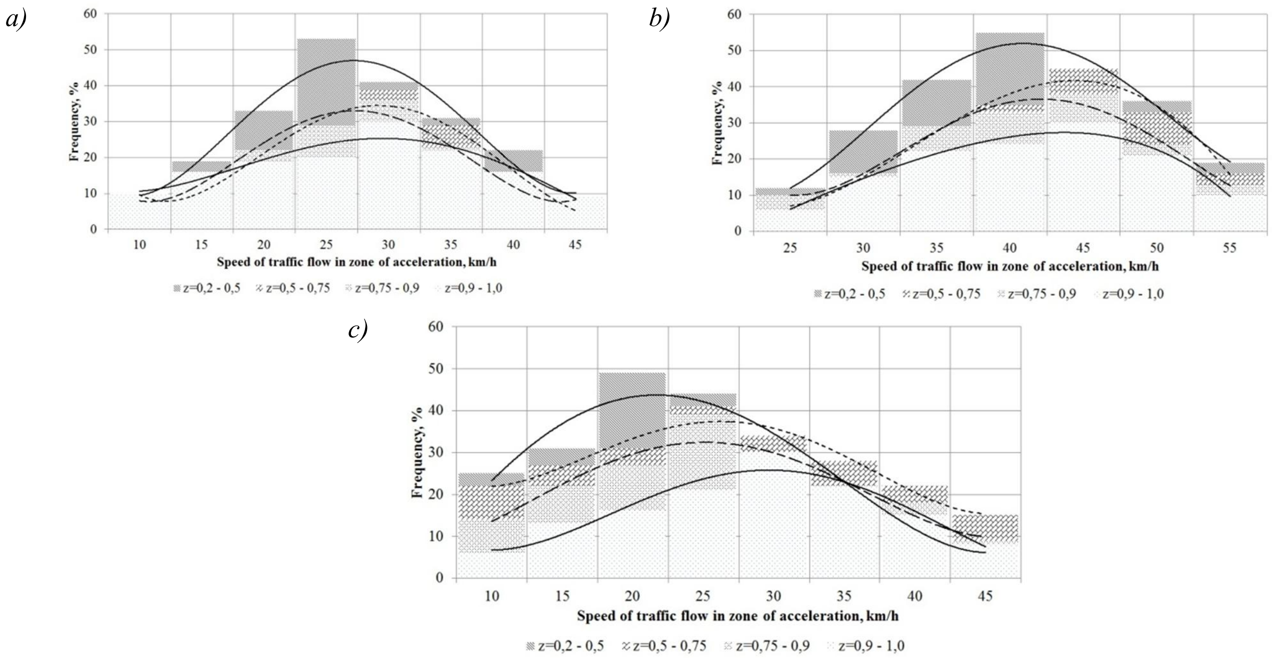

Fig. 9. Distribution of average speed for middle section between intersections:
a – for zone of acceleration; b – for zone of constant speed; c – for zone of braking

Analyzing Fig. 8 and Fig. 9, we can say that the highest average speed is when volume-capacity ratio corresponds to free movement conditions (z = 0.2 – 0.5). Comparing two types of sections between intersections, we can say that average speed in zone of acceleration is 25 km/h and 30 km/h respectively for the 1-st and the 2-nd type of section, in zone of constant speed – 35 km/h and 40 km/h respectively, in zone of braking – 30 km/h and 30 km/h respectively.

To determine the recommended speed of movement on arterial directions, it is necessary to take into account road conditions that are formed with simultaneous impact of several factors: volume-capacity ratio of the intersection in zone of braking, volume-capacity ratio of intersection in zone of acceleration, number of lanes, the length of section and the average speed of traffic flow.

Recommended scheme for the determination of estimated flow speed on arterial investigated streets taking into account existing movement conditions, volume-capacity ratio of the roadway, traffic flow intensity and composition is given in Fig. 10.

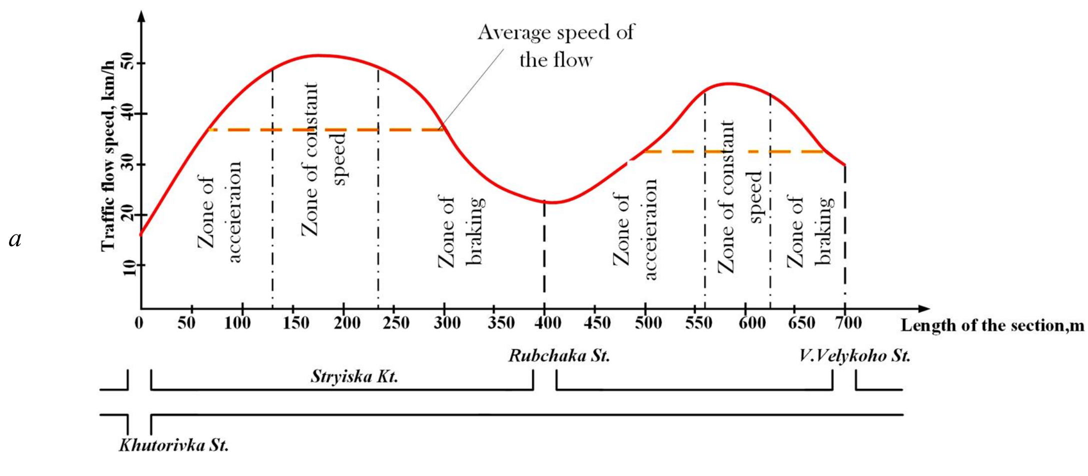

Fig. 10. Scheme for determination of estimated speed of traffic flow on arterial street:
a – Stryiska Str. (between intersections of Stryiska – V. Velykoho Str. and Stryiska – Naukova – Khutorivka Str.)

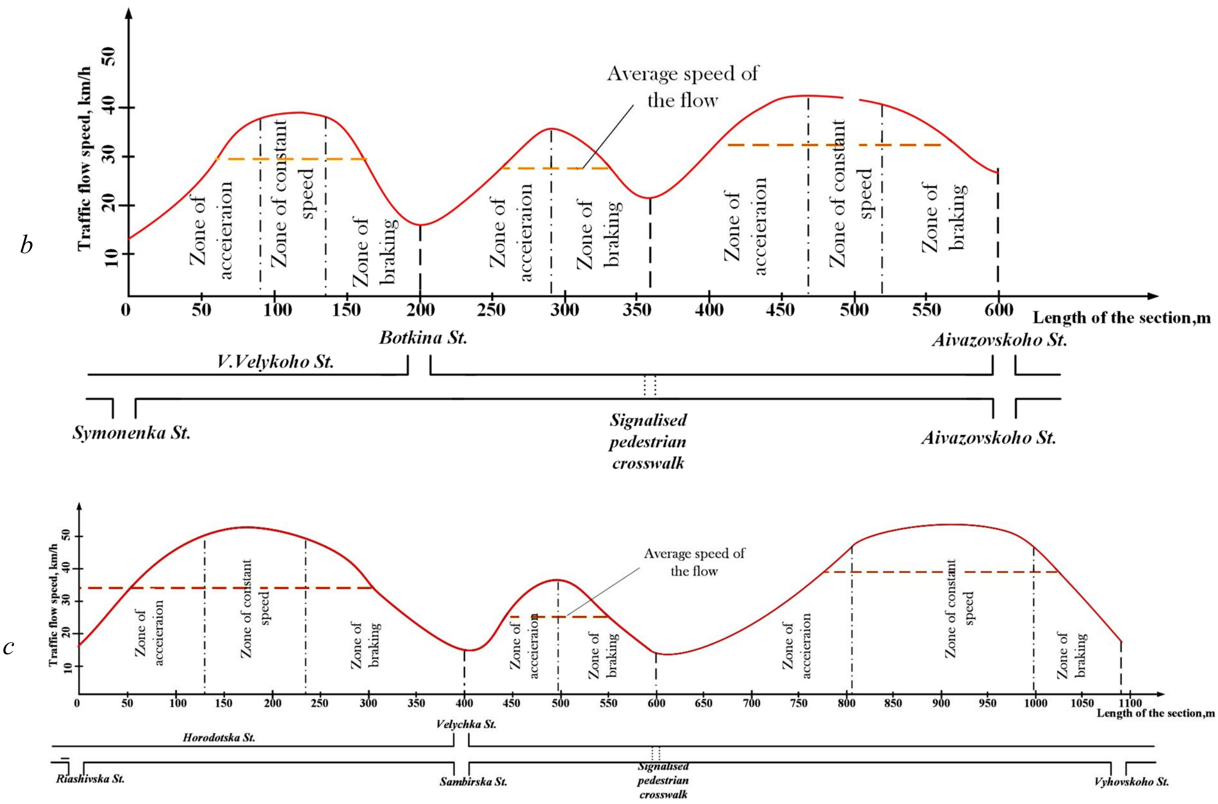

Fig. 10 (Continuation). Scheme for determination of estimated speed of traffic flow on arterial street:
b – V. Velykoho Str. (between intersections of V. Velykoho – Aivazovskoho Str. and V. Velykoho – Symonenka Str.);
c – Horodotska Str. (between intersections of Horodotska – Vyhovskoho St. and Horodotska – Riashivska Str.)

It is established that maximal speed of movement on sections between intersections at volume-capacity ratio 0.6–0.8 changes from 10 to 45 km/h, in certain cases exceed permitted speed 50 km/h. Average actual speed on the section of Stryiska St. is 35–38 km/h, on the section of V. Velykoho St. is 30–33 km/h, on the section of Horodotska St. is 34–37 km/h. Proposed system will operate effectively with estimated speed of 30–40 km/h, which takes into account road and movement conditions. Analyzing Fig. 10, we can see that the average speed of traffic flow on short sections between intersections (length to 300 m) is 27–33 km/h, on sections of middle length – 35–38 km/h.

5. CONCLUSIONS AND FUTURE RESEARCH PERSPECTIVES

So, to increase the effectiveness of arterial streets functioning, it is recommended to establish the average speed of movement as the estimated speed with consideration of complex impact of several factors: volume-capacity ratio of signalized intersections and sections between intersections, number of lanes, the length of the section, traffic flow composition and the presence of deformations and defects on the road pavement. Such speed will allow traffic flow falling into the line of constant movement in given road conditions. Carried out research allows considering road and movement conditions more completely during the justifying the estimated speed of traffic flow. In result, capacity of arterial streets of controlled motion increases.

The aim of further scientific research in this direction is development of recommendations about capacity increase based on the estimation of interaction of traffic flow with arterial streets of controlled motion.

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ПІДВИЩЕННЯ ПРОПУСКНОЇ ЗДАТНОСТІ МАГІСТРАЛЬНИХ ВУЛИЦЬ З РЕГУЛЬОВАНИМ РУХОМ

Анотація. *Розглянуто проблему підвищення пропускної здатності магістральних вулиць із регульованим рухом. Вибрано прогони вулично-дорожньої мережі міста Львова за різної довжини і ширини проїзної частини, зокрема з найнасиченішим дорожнім рухом. Проаналізовано методи підвищення пропускної здатності магістральних вулиць регульованого руху, а також чинники, які впливають на зниження пропускної здатності. Розраховано пропускну здатність перехресть за різного рівня їх завантаження. Побудовано розподіл середньої швидкості руху для прогонів різної довжини. Встановлено, що на прогонах середньої довжини між регульованими перехрестями і високим коефіцієнтом їх завантаження швидкість транспортного потоку не досягає максимальних значень. Підвищити швидкість і пропускну здатність прогонів можливо у разі збільшення їх довжини, достатньої для розгону потоку до максимальної сталої швидкості й подальшого гальмування* *перед перехрестям. Для визначення рекомендованої швидкості руху на магістральних напрямках враховано дорожні умови, які формуються у разі одночасного впливу декількох чинників: рівня завантаження перехрестя у зоні гальмування, рівня завантаження перехрестя в зоні розгону, кількості смуг руху, довжини прогону і середньої швидкості транспортного потоку. Визначено, що середня швидкість транспортного потоку на коротких прогонах (довжина до 300 м) становить 27–33 км/год, на прогонах середньої довжини – 35–38 км/год. Така швидкість дасть змогу транспортному потоку потрапляти в смугу невпинного руху в заданих дорожніх умовах. Виконані дослідження повніше враховують дорожньо-транспортні умови під час обґрунтування розрахункової швидкості транспортного потоку. В результаті цього підвищується пропускна здатність магістральних вулиць регульованого руху.*

Ключові слова: *вулично-дорожня мережа, транспортний потік, інтенсивність руху, швидкість руху, пропускна здатність, рівень завантаження, моделювання руху, натурні дослідження, регульовані перехрестя.*