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KHIVA CITY TRAFFIC DENSITY ANALYSIS

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Abstract: In this article, the analysis of the traffic density of vehicles moving in Khiva city street-road networks and the models of dependence parameters of speed-density, flow-density, and flow-velocity relationships have been developed. Proposals and recommendations are presented based on the developed models.

Keywords: Street-road network, speed, flow, density, intensity, average flow speed, density at peak time, free flow speed.

Introduction

The state and development of transport is of particular importance for the historical city of Khiva. Transport, along with other infrastructure sectors, is an important means of achieving social, economic, and foreign policy goals, and provides the basic conditions of society's life.

Traffic flow density is the main macroscopic characteristic, traffic flows are used to evaluate traffic efficiency. Difficulty in measuring density prevented its general use until the early 1960s when detectors of the current type became available. Density is also an important measure of the quality of traffic flow, as it is a measure of the proximity of other vehicles, a factor affecting the freedom of maneuver and the psychological comfort of drivers. For these reasons, the traffic flow dynamics book [1] used traffic density as the main measure of service level for continuous flow situations.

Thousands of drivers and passengers moving from one place to another form different traffic flows. The flow of cars on road networks, the flow of bicycles on the streets, the flow of people in subway stations, and the flow of pedestrians in pedestrian crossings all vary depending on the time of day, the day of the week, and the month of the year.

Flow measurements and modeling of traffic events are required to assess vehicle capacity, as well as to make appropriate decisions on vehicle flow development.

Flow measurements and analysis facilitate the forecasting of future design solutions for average speed on street networks and are a key parameter that characterizes the distribution of vehicle flow over an area over time. Flow measurements also help determine flow lengths, service levels, and take actions to help alleviate congestion.

Methods and materials

Many scientists have researched the theoretical and experimental aspects of transport density [2-9]. Traffic flows can be characterized using various parameters. Studying the flow of vehicles involves the study of the behavior of individual vehicles over time (changes in speed, changes in direction, and other factors).

We are often interested in the macroscopic approach, which involves the description of traffic flow conditions by various aggregate parameters, for example, average traffic speed, average direction, traffic density, etc.

In particular, this study aims to investigate the correct index of the macroscopic flow variable at mixed motion velocities. It is necessary to describe the flow rate and traffic density capable of effecting the change of vehicles, which in turn needs to determine the specific criteria of the change of vehicles in order to establish the correct index of these variables. Thus, the flow rate and density indicator changes, which takes into account or does not take into account the indicators of the transport object. Then, in the main diagram (flow-density, velocity-flow, velocity-density plane) the influence can be shown by comparing all the indices to describe the traffic situation. Finally, this results in a flux and density index corresponding to the mixed motion velocity.

The measurement range of a macroscopic variable is defined by three main variables from a macroscopic perspective: density, flow rate, and flow. From this point of view, the traffic situation can be characterized by the relationship between these variables. A total of three variables are always related by a fundamental relation or identity relation, which can be expressed by equation (1) [10].

Taking into account the above, in determining the traffic density of motor vehicles moving on the street-road networks of the city of Hiva, it was determined taking into account the speed of movement of motor vehicles (veh/hour) in the source [11]. In order to determine the traffic density, we define the amount of traffic (vehicles/hour) moving vehicles in lane 1 over time [12]. should be put

$$\mathbf{K}= \frac{q}{\bar{U}_s} \text{ ....}\mathbf{(1)}$$

бу ерда

q- The flow of motor vehicles moving in the 1st traffic lane of the street network (cars/hour);

$\bar{u}_s$- Spatial average speed of motor vehicles moving in the 1st lane of the street network (km/hour);

k- Density of motor vehicles moving in the 1st lane of the street network (car/km).

In order to find the traffic density, we can record the speed with a certain level of accuracy with the help of various equipment (radar, stopwatch, inductive sensors). There are two ways to describe speed in a street network:

1. average speed over time;
2. cosmic mean velocity.

We use the space-averaged speed, which seems to us the simplest option, the space-averaged speed is the average speed used in most traffic models. In order to find the average speed, we need to calculate the average travel time of a number of cars over a distance of 1 km, and we determine it using the following formula:

$$\bar{u}_s = \frac{D}{\frac{1}{n}\sum_{i=0}^{n} t_i} = \frac{D}{t} \text{................................}(2)$$

here $\bar{u}_s$- space average speed (km/h);

D- The length equal to D part of the street-road network length (km);

t_i- travel time determined using a stopwatch (seconds);

n- The number of cars (units) in measuring the travel time spent on the D part of the length of the street-road network;

t- 3600 seconds available in 1 hour.

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$\sum_{i=0}^{n} t_i$ – represents the average movement time of vehicles moving along the observed highway section.

For example, we find the average travel time of the state highway 4r158 (Urganch-Khiva):

As a result of experimental research, we have found the following:D=1km; n=5; t_1=62;t_2=53; t_3=52; t_4=56; t_5=56; t=3600; q=331 veh/h.

$\sum_{i=0}^{n} t_i$ =62+53+52+56+56=279(сек)

we have a total of 279(sec) measured from 5 vehicles, and we convert the total travel time found to hours:

for that $\frac{279(\text{сек})}{3600(\text{сек})}$= 0,0775 (h).

$\frac{1}{n}\sum_{i=0}^{n} t_i$ - we determine the average travel time:

$\frac{1}{n}\sum_{i=0}^{n} t_i = \frac{1}{5}(0{,}0775) = 0{,}0155$ (h)

We determine the space average speed according to formula 2:

$\bar{u}_s=\frac{1}{0{,}0155}$= 64,3 km/h.

The traffic density of motor vehicles moving in 1 km of the state highway 4r158 (Urganch-Khiva) is found using formula 1.

k=$\frac{331}{64{,}3} = 5{,}2$ veh/km.

When determining the transport density, we determine the interdependence of speed ($\bar{u}_s$) and density (k), speed and flow (q), and flow and density parameters from the following formulas. We can find the expected maximum flow (q_m), the free-stream speed (u_f), and the congestion density (k_j) using the defined flow, average space velocity, and densities using the above formulas.

From the determined k-density, the density at the time of k_j-traffic jam is found using the following formula:

k_j=2*k*……………………………………….....*(3)*

where k_j is the density at the time of congestion (the time when the flow and speed are zero).

We assume that all parabolas are symmetric about the axis of symmetry in order to model the dependence of the maximum current and density. In our case, the coordinates of the parabola intersect at the points (k_m,q_m,).

$k_m = \frac{k_j}{2}$……………………………………..(4)

$q = u_f(k - \frac{k^2}{k_j})$…………………………………….(5)

$u_m = \frac{u_f}{2}$……………………………………………(6)

where u_f- free-stream speed;

u_m- we assume that the speed corresponding to the largest current is approximately equal to $\bar{u}_s$.

The maximum current q_m is calculated using the following formula:

$q_m = u_m k_m$ ……………………………………….....*(7)*

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$$q_m = \frac{u_f k_j}{4} \quad \text{.......................................(8)}$$

Results

In order to determine the traffic density of motor vehicles moving on the street network of the city of Hiva, taking into account the fact that experimental studies were carried out during 2 hours on the highways of state and local importance, we divide by 2 to get the speed of movement during 1 hour, and on city streets, we divide by 1 experimental studies were conducted during the hour. During the research, while taking into account the speed of traffic on the city's street-road networks, the travel times of vehicles moving in the 1st traffic lane were measured using a stopwatch and their densities were determined (Table 1).

The purpose of studying the traffic density is that we can observe when the vehicles moving in the 1st traffic lane of the highways move at a free flow speed and their speed, when the density determined as a result of the analysis reaches the density at the time of congestion, we can observe in the speed and density models. In the flow-density relationship model, the maximum flow capacity is reached at the spatial average speed, and when the density is reached during the traffic jam, this flow tends to zero. In the velocity-flow relationship model, we see that the flow tends to zero when the free-flow velocity is reached, and reaches the maximum flow at the space-averaged velocity. Interdependence models of the traffic density parameters of motor vehicles moving on the street-road network of the city of Khiva are presented in Figure 1.

Table 1. Traffic density of motor vehicles moving on the street network of the city of Khiva

№	the name of the street-road network	Total travel time (sec)	Space Average Speed (km/h)	intensity (car/h)	k	k_j	k_m	u_m	u_f	q_m
1	4r158 (Urganch-KHiva) highway	279	64.3	331	5.1	10.2	5.1	64.3	128	331
2	4r163 (Bogot-KHiva) highway	388	46	494	10.7	21.4	10.7	46	92	494
3	4r163 (Gurlan-Khiva) highway	408	44	342	7.8	15.6	7.8	44	88	342
4	4r265a Khiva Ring Road	221	57	770	13.5	27	13.5	57	114	770
5	4r264 (Yangibozor-KHiva) highway	276	65	83	1.3	2.6	1.3	65	130	83
6	4r265 Khiva compressor highway	398	45	215	4.8	9.6	4.8	45	90	215
7	4r164 (Yangiarik-Khiva) highway	406	44	218	5	10	5	44	88	218
8	4k986 highway	185	29	985	34	68	34	29	58	985
9	Amir-Temur street	218	41	190	4.6	9.2	4.6	41	82	190
10	Najmuddin	117	46	456	10	20	10	46	92	456

	Kubro street									
11	Feruz 1 street	178	31	485	15.6	31.2	15.6	31	62	485
12	Feruz 2 street	175	15	348	23.2	46.4	23.2	15	30	348
13	Independence and R. Madjidi street	384	47	452	9.6	19.2	9.6	47	94	452
14	R. Allaberganov street	186	48	212	4.4	8.8	4.4	48	96	212
15	Beruni street	229	47	370	7.9	15.8	7.9	47	94	370
16	Yakubov street	254	57	97	1.7	3.4	1.7	57	114	97
17	E. Allayorov street	255	40	117	2.9	5.8	2.9	40	80	117
18	Okhunboboev street	227	38	375	9.9	19.8	9.9	38	76	375
19	Zhargarlar Street	129	28	106	3.8	7.6	3.8	28	56	106

Based on the data presented in Table 1, vehicle densities were determined, which in turn prompted the development of traffic density models. The traffic density model of one 4r158 highway is presented in Figure 1, taking into account the large number of natural experiments conducted on Khiva city street-road networks.

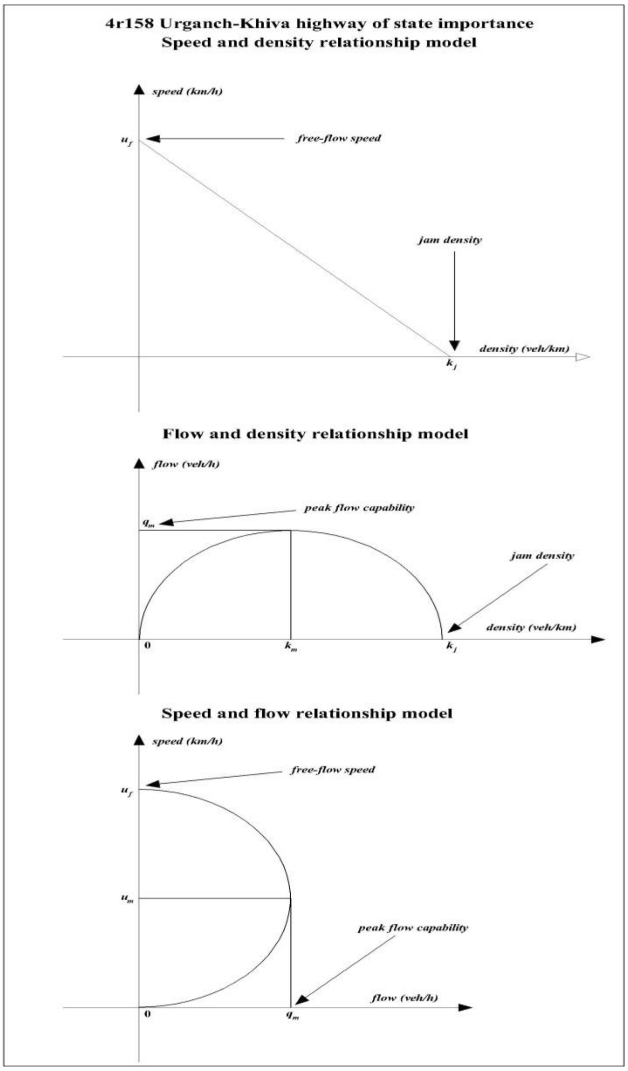

Figure 1. 4r158 (urganch-hiva) car of state importance interdependence model of speed, flow and density parameters of the road

As we can see in Figure 1, in the speed-density relationship model, the free-flow speed is expected to reach 128 km/h in the line, and the vehicle's acceleration speed is expected to be zero when the density of 10.2 veh/km is reached. In the flow-density dependence model, these indicators were observed in the 1st traffic lane of motor vehicles moving during peak hours of the day, with a flow of 331 vehicles per hour, which was a traffic density of 5.1 veh/km. In the speed-current dependence model, the following was determined from these indicators: if vehicles move at an average speed of 64 km/h, the flow was 331 veh/h, and if they move at a speed of 128 km/h, the traffic density (veh/km) tends to zero.

Conculsion

It is necessary to take into account the following suggestions and recommendations in order to properly organize the flow of motor vehicles entering the city of Khiva:

Development of a new bypass project adjacent to the access roads to the city;

Establishment of new overpasses at city entrances;

Improvement of design solutions of transport nodes at city entrances;

Development of measures to increase traffic lanes on the roads at the entrance to the city.

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