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THE PRINCIPLE OF GENERALIZED POTENTIAL AND CFPACITI OF TRAFIC LANES AND ROADS AT CROSS-SECTIONS AT DIFFERENT LEVELS

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Abstract. Huk V. I. "The principle of generalized potential and capacity of traffic lanes and roads at cross-sections at different levels." As a general criterion that determines the throughput of intersection types in different levels of main thoroughfare and roads, a new characteristic is given, such as traffic capacity, taking into account the speed reduction factor in the process of the lanes' change.

Keywords: Traffic, traffic potential, intensity, speed, density, inertia, flow rate, capacity, motorway

Introduction

Public highways, as well as main streets of the city, should provide high-speed communication between the centers of gravity of autotravels. The continuous flow of traffic on the roads of roads and urban highways is provided by the construction of various types of sections at different levels. Different types of crossings: clover leaf, ring, loop, rhombus [2], and with lane movement (cross-shaped) - have different bandwidth, which is equal to the maximum value of the intensity in the intersection.

Research methods

The road or city highway constructed according to the project has an opportunity to provide traffic to the level of throughput, and then - at the level of the congestion and to the gate. This possibility of road work in [1] is defined as a road potential, which varies from the maximum value on the empty road to zero during traffic jam (traffic). As you know, the state of the traffic flow in the section of the road is determined by the intensity (N), which is derived from the amount of flow at time dq / dt, and in space - velocity (V), as the derivative of the path along the time dl / dt.

In the traffic flow, the intensity influences the speed of the cars, but the intensity is the characteristic of the section, so it is advisable to take into account the variable intensity in time N (dt), then the number of flow (q) (auto). This is one car or group: q (t) = JV (t); N = d (q) [2]. Formed law that indicates: the change in the intensity of traffic for a certain segment of an hour is equal to the change in the amount of flow for the same period of the hour. And this allows, on the initial speed of the V0 and the specified q flow, to find the final speed of the vehicles in traffic, bypassing all additional speeds.

Traffic inertia, in turn, characterizes the distribution of hours by car by the length of the J = q / V (autos / km) lane, where J is defined as the inertia of speed change in traffic. These findings allow you to increase the speed of traffic, distributing it to groups whose speed is much greater than the speed of traffic in the state of the congestion (in road toffees).

It should be noted that the intensity at the intersection at the level of throughput in 1500 cars per hour in one lane is determined by the distribution of traffic in the length of 30 km. On this distance, traffic can not be permanent. The speed of cars will change.

Taking into account the recommendations in [3] and duality of the car as units of traffic and units of speed, we find the connection between the speed change of cars in the dV / dt stream, assuming that the specific intensity operates along the axis of the road. The equation of traffic in cars has the form

$$J\frac{dV}{dt} = N \quad , \qquad (1)$$

where J is the speed inertia (km / h)
Multiplying both parts of this equation by V we obtain

$$d/dt\,(JV^2/2)=NV \qquad (2)$$

where, the result of NV = M is the power of traffic (avt.km / h2) [1],

$JV^2/2$ traffic potential (car km / h) $JV^2/2 = E_d$

The traffic potential remains constant only in the absence of intensity, because at N = 0. in any section there are no cars, and the way is

$$\frac{JV_{x_2}{}^2}{2} = \frac{JV_{x_1}{}^2}{2} = const \quad , \qquad (3)$$

or the amount of flow in the group does not change q = const.

This is the law of maintaining the performance of the road, highway, or road potential.

Research results

Consider now what is the power of the traffic flow M, which characterizes the rate of change in the efficiency of the system of "traffic flow", committed by the cars of the flow

$$M = \lim_{\Delta t \to 0} \frac{\Delta H}{\Delta t} = \frac{dH}{dt}$$

Using the basic transport flow equation (N = QV), where Q determines the density of traffic, as opposed to traffic, with its maximum value of traffic of vehicles, we find the dependence of the power of the flow on the speed where dx - the infinite small displacement of the car of the stream, which is influenced by the intensity, for time element Δt.

Therefore, the power of the traffic flow

$$M = \frac{dH}{dt} = (N\frac{dx}{dt}) = (NV)$$

where V is the speed of the vehicle of the traffic flow. This is the instantaneous power value (3.49).

Using the basic equation of the transport stream (3.20), we obtain the dependence of the power of the flow on the velocity

$$M = Q_m\left(1 - \frac{V}{V_0}\right)V^2 \quad , \qquad (4)$$

graphically represented on fig. 1

As we see from the graph, the power, like all the main characteristics of the traffic flow, has a growth area, an optimal zone at a speed of 60-70 km / h and a sharp drop. The variation of the power M under the influence of the density M (Q) is obtained using the equation N = QV and then

$$M = \frac{N^2}{Q} = QV_0^2\left(1 - \frac{Q}{Q_m}\right)^2$$

(5)

The graph of this dependence is given in Fig. 2, where it is evident that the optimum values of density at the maximum value of traffic capacity Mm are within 30-40 aut / km. That is, cars move at a distance of 20-25 meters from each other. The graph also shows foreign data that correspond to the concept and units of power measurement.

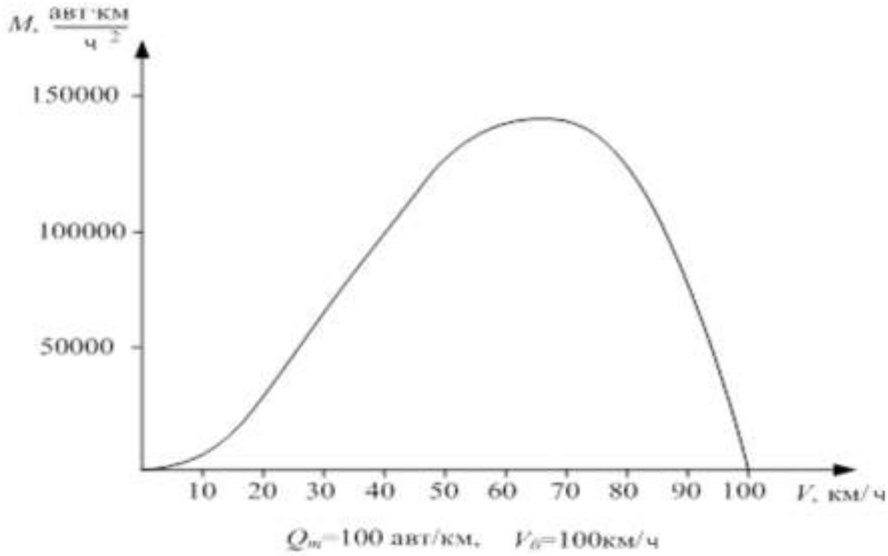

Fig. 1. Dependence of traffic power from its speed [3]

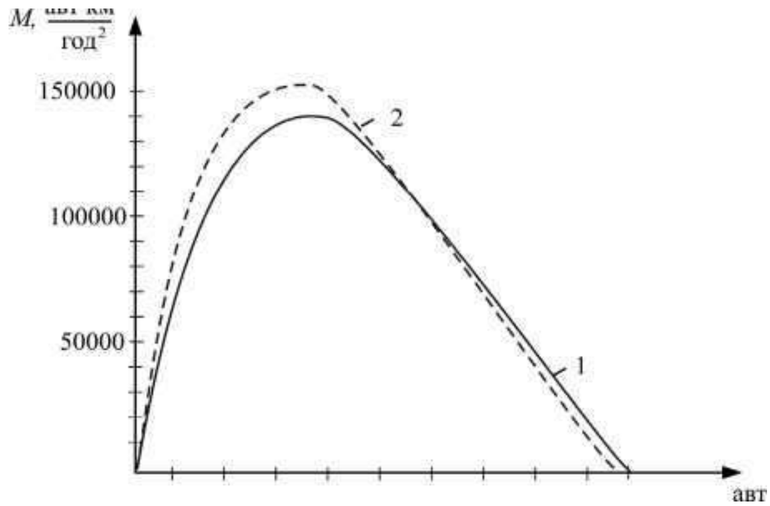

Fig. 2. Dependence of power M on density Q [3]

Getting and analyzing power dependence on intensity is difficult, because you need to know the law of entering cars on the road section. Therefore, we use the graphical data of theoretical and experimental curves and the equation of instantaneous power (5), in which we will substitute the coordinates of the curves N and V.

Figure 3 shows the desired dependence of M (N). The graph is original and very interesting. Curve 1, constructed according to the equation (5), is close to the shape of the "Carton Letter". Experimental curves 3a and 3b are quite close to the theoretical curve, which confirms the correctness of the theoretical statements [3]. In this case, curve 2 is obtained by field observations in the conditions of increasing speed and intensity of the car traffic to the level of bandwidth, and curves 3a and 3b on multiband roads in conditions of decreasing speed with increasing intensity in conditions of motion at the intersection of the loop type, that is, at the level of the throughput the ability that we see on fig. 2.

Discussion of results

The nature of the change of power from the composition of the transport stream, which is determined by the size of the maximum density and conditions of motion, providing the speed of free motion V0, is shown in Fig. 3.46. On the graph, we see that the speed of free motion is a tangent of the angle of inclination of the axis of symmetry of the graph, and the maximum density characterizes the level of bandwidth of the lane. The axis of symmetry separates traffic conditions to the level of bandwidth and after reaching this level.

The concept of "power" is a natural and generalizing extension of the notions of the "number of traffic" (auto.km), road transport potentials and exergy (auto.km / h) as a characteristic of their change in time (auto.km / h), that is, a generalized variable system of "traffic flow", characterizing changes

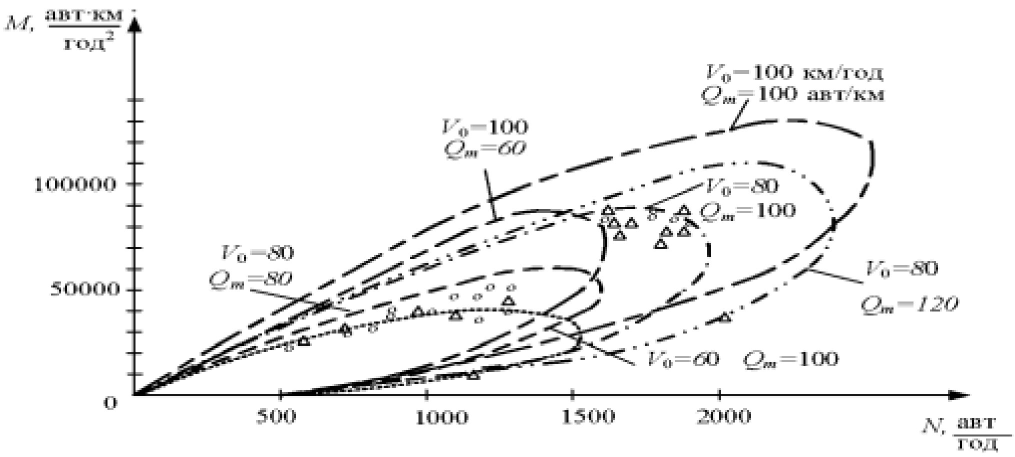

Fig. 3. Nature of power change M from the composition of the flow (Qm) and the free movement speed V0

The close convergence of the theoretical curve with the results of field observations allows us to recommend the equation of traffic power for practical use, not only in assessing the load and condition of traffic on different sections of the sections at different levels of streets and roads, but also in predicted calculations in project development as a criterion for loading in general roads.

Since the road potential is a characteristic of safe traffic conditions, its optimal value, as well as the value of power, should be included in the normalized values of the throughput of the city highways.

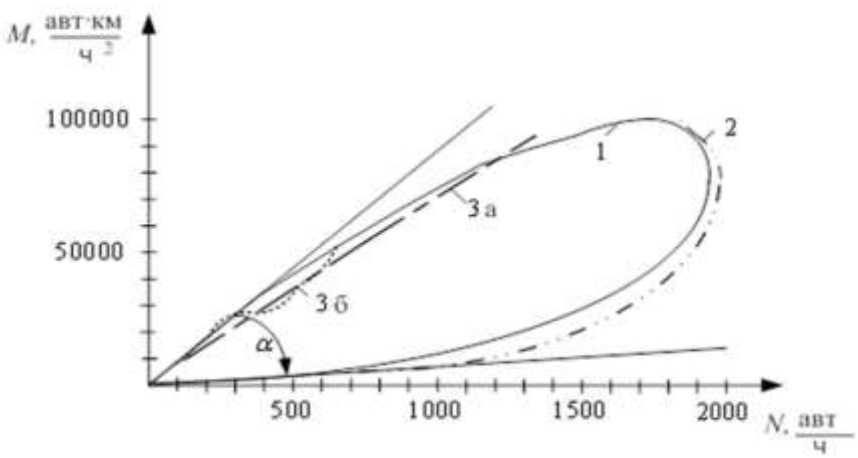

Fig. 4. Dependence of power M on the intensity of N [3].

In order to take into account traffic delays within the changes of lanes in approaches to cross-sections at different levels, we suggest using the corresponding delay factor presented in [4], along with the coefficients of change in the bandwidth of different lanes.

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ПРИНЦИП УЗАГАЛЬНЕНОГО ПОТЕНЦІАЛУ ТА ПРОПУСКНОЇ ЗДАТНОСТІ СМУГ РУХУ І ДОРІГ У ПОПЕРЕЧНИХ ПЕРЕРІЗАХ НА РІЗНИХ РІВНЯХ

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Анотація. Розвиток швидкісного пасажирського транспорту одна з найважливіших завдань для успішного функціонування транспортної системи будь-якого великого міста.

Для створення у великих містах України, особливо зі складними кліматичними і геологічними умовами, а так само зі слабко розвиненою системою автомобільних магістралей, пропонується новий, надземний, високошвидкісний, екологічно чистий, електричний, пасажирський, з кабінами, економічний транспорт. Для організації безпечного руху керованих екіпажів з пасажирами використана теорія насичених транспортних потоків, яка рух екіпажів в потоці описує як безперервну зміну станів прискорення, рівномірного руху і гальмування, тобто синхронізовані три фази «start-go-stop» в одному керуючому алгоритмі.

Безперервній рух транспортного потоку (трафіку) на трасах автомобільних доріг та міських магістралях забезпечують сучасні типи перетинів в різних рівнях різного дизайну. Застосуванні відкрити та обгрунтовано нові характеристики динаміки транспортних потоків (трафіку) ,такі як потенціали дороги, транспортного потоку і потужності трафіку для визначення дизайну загальної працездатності шляху.В якості загального критерія, що визначає пропускну спроможність типів перетинів в різних рівнях магістральних вулиць та доріг доводиться нова характеристика, як то потужність трафіку з урахуванням коефіцієнту зменшення швидкості при зміні смуг рух. Вказано на дуальність автомобіля, як одиниці трафіку та одиниці швидкості, Сформовано закон - зміна інтенсивності трафіку за деякий відрізок годині дорівнює зміні кількості потоку за той ж відрізок годині. А це дозволяє по

початковий швидкості автомобілів V_0 та визначений кількості потоку q знаходити кінцеву швидкість автомобілів у трафіку, обходячі усі додаткові визначення швидкості.

В якості загального критерія, що визначає пропускну спроможність типів перетинів в різних рівнях магістральних вулиць та доріг доводиться нова характеристика, як то потужність трафіку з урахуванням коефіцієнту зменшення швидкості при зміні смуг рух.

Ключові слова: Трафік, дорожній потенціал, інтенсивність, швидкість, щільність, інерційність, кількість потоку, потужність, автомагістраль.