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Designing traffic distribution for non-signal intersection of transport interchanges in one level in the central business districts of the city

CBD - is the central business part of the district or city, it has a large number of modern infrastructure facilities, such as business facilities, financial structures, cultural facilities and communications. This requires perfect and rapid transport communications. However, as the number of cars increases rapidly, over the past 10-15 years, municipal roads are already unable to withstand complex transport loads, which leads to overloading in the central business part, as a result of which traffic jams become a global problem that seriously limits the growth of indicators GDP in the regions, the possibility of electricity consumption, land use and development of the environment.

Analysis of the causes of congestion in the cities reveals two main reasons: the first is a rapid increase in the number of vehicles, the second is the lack of proper development of urban roads in the horizontal and vertical planes, relatively short adjacent intersections and an excessive number of traffic lights [1]. Based on the development of modern vehicles and various restrictions in the development of central business districts, this work offers a new type of solution to the problem of traffic jams. A specific approach and innovation is to reorient the entry/exit of roads at intersections, to abandon traffic lights, not to share street transport, half-digging and semi-rigid steel miniature interchanges, tubular horizontal lanes of oncoming traffic, direct left early separation and later fusion and other elemental and combined innovations to achieve the intersection of vehicles without traffic lights, etc. In ideal conditions, there is a desire to achieve such traffic, in which there is then. Only the beginning and end of the vehicle's movement, as well as the function of communicating interchanges in the plane, to solve the problem of urban congestion.

1 Background research

1.1 Danger of traffic jams.

Traffic jams not only lead to the decline of many functions of the economy and society, but also leads to a permanent deterioration of the urban living environment, which has become a "disease" that hinders the development of the city. Direct impact on residents is expressed in increasing travel costs, increasing travel time, lowering the efficiency of work, limiting the daily activities of people and significantly reducing the quality of life of residents. Negative impact on the country and the region is expressed in a serious limitation of GDP, energy consumption, land use, environment and other types of healthy development. Therefore, traffic jams, both for the country and for individuals, bring only harm and no benefit.

1.2 Reasons for traffic jams

After conducting a large number of municipal surveys of congestion in central business districts and visits with relevant experts, five main causes of traffic congestion were found. They have both superficial single causes and deeper mixed problems:

- the rapid growth in the number of cars caused an excessive load on the road network;

- rain, snow, road accidents, road damage and other insurmountable external factors that a person can not artificially change;

- in the center of the city too many blocks, too many intersections, and it is impossible to achieve movement on the "green wave." As a result, the number of vehicles entering the intersections from outside is greater than outgoing, which causes a serious oversaturation of traffic;

- the roads in the central business districts are wide and the three-dimensional traffic is limited, and the sequence of traffic along the roads with a significant mix of transport and pedestrians is erratic;

- the irrational distribution of intersections, the narrowness of the intersections and the irrational timing of the traffic lights lead to the fact that at the intersections in a certain range the number of incoming vehicles significantly exceeds the number of outgoing vehicles, which leads to traffic jams.

1.3 Current state of related research at home and abroad

Crossroads are being given considerable attention in developed countries such as Europe, the US, Japan and Australia [1]. The study of these problems began quite a long time ago and achieved comparatively good results. In the system of transport interchanges, the United States developed the Intelligent Transport System (ITS) in 2003. In the field of transport conflicts in 1999, Mikko Rozanen proposed giving priority to planning the movement of the function of collision between motor and non-motor vehicles. With respect to the plane of traffic interchanges, the theory of the maximum bandwidth of limited space in the ITS laboratory of the American Experimental Traffic Center in 1994 fully took into account the relationship between delay, queue length and traffic jams. In the issue of the management of flat transport interchanges in Europe, America, Japan and other developed countries, there are progressive methods of flow distribution, namely, areas of primary delay, rings for machines without separation, roads only for public transport, coordinated design of space-time groups at intersections and design of space-time separation for fast and slow movement.

Studies related to the design of crossroads in central business areas, conducted in China, initially focused on the introduction and study of foreign technology [2]. In recent years, many international studies have also been conducted, such as the one-channel neural network control system with fuzzy logic with inductive control, proposed by the Chinese researcher Xu Donglin, as well as the theory of shape geometry management proposed by Ma Yen, etc. Mixed aspects of the movement were investigated in 2006. Peking University Qian Linem, etc. A method of chaotic time series was used to analyze the interference of groups of non-motor vehicles with motor vehicles and a large number of interference coefficients was determined. In the area of the study of traffic light control in 1998, Gu Huai-

chung and Wang Wei proposed a global simulation algorithm for the selection of flexible traffic times at traffic junctions. In the field of distribution of transport interchanges in connection with a complex road environment in China, traffic sewage is more developed, therefore, left turnings, tidal paths and circular traffic are effectively used.

2 Design principle

2.1 Design Ideas

2.1.1. Analysis of traffic jams under the control of traffic lights

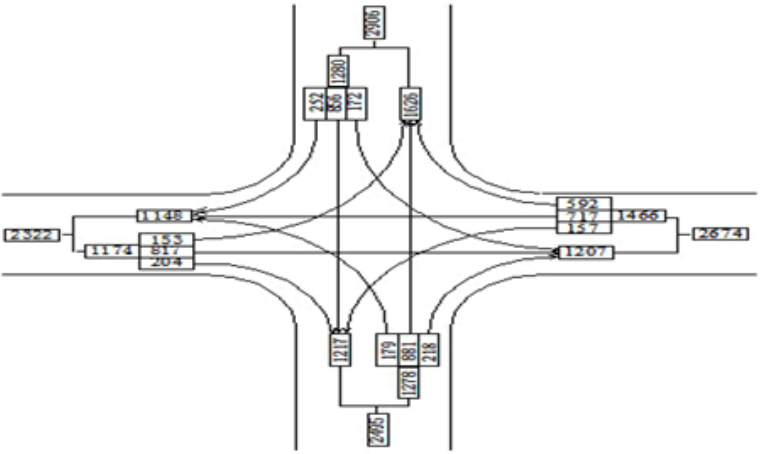

Fig. 1. Scheme of the traffic direction of the traffic intersection.

Combined Fig.1. In accordance with the point of conflict non-signal transport interchange and the formula for calculating the point of divergence-merging, you can find the conflict point and the number of points of intersection:

$$Cj=(nn(n-1)*(n-2))/6 \quad (1)$$

$$Cf=Cn=n(n-2) \quad (2)$$

Summing up, it turns out an ordinary road with four entrances. At the intersections of the straight line, left and right lanes, there are 16 points of conflict, 8 points of separation and 8 points of confluence. According to the current traffic light, two-way direct traffic between east and west, two-way traffic between east and west with left turn, two-way direct traffic between north and south, two-way north-south traffic with four phases with left turn must be organized to resolve conflicts [2]. This leads to the necessity of cars arriving at the same time for the traffic intersection, to pass the excessive time of three phases (three green lights + three yellow lights + three fully red ones), continuing to line up, especially if unattainable continuous movement with a short green-wave switching on the next roundabout. Vehicles in the bulk are trapped on adjacent sections of the road, and external

vehicles continue to continuously enter the traffic intersection, resulting in a permanent traffic jam. This is even more unbearable for the morning and evening peaks. Therefore, traffic lights are an important cause of congestion in urban transport.

2.1.2 Cancel traffic lights at the traffic intersection.

For this fig. 1, rule 1 is provided: the incoming road from south to north is designated as A-entry, the incoming road from west to east is designated as B-entry, the incoming road from north to south is designated as C-entry, and the incoming road from the east to west is designated as D-entry. All right turns are denoted by 1, all straight roads are denoted by 2, all left rotary bands are denoted by 3; four noncentral interchanges are called white bridges, and the central interchange is called the blue bridge.

For this traffic intersection, rule 2 is provided: pedestrians and non-motor vehicles have been completely separated from motor vehicles; road-weather conditions are normal.

In conditions (1) (2), an analysis of the mode of transmission of the traffic plan was carried out:

a. A1, B1, C1 and D1 unobstructed cruising along the direction signs (and no changes with the stage before traffic distribution).

b. At the beginning (A2, A3) will travel together along the left straight suitable strip from the south to the north, before meeting the first white bridge. After the joint passage under the bridge, they will reach the blue bridge to the separation mark of the stream in order to prepare for the separation. They will move to the mouth of the place of separation, they will disband [3], then A2 will pass the central traffic intersection under the blue bridge, directly drive to the second white bridge to pass through the bridge; A3 turns left, follows the pointer to the second white bridge and rides over it. Finally, all traffic is completed on the A-entrance - through, left turn and turn right. The trajectory of C-entry is exactly the same as for A-entry.

c. Inputs B, D and input A pass through the bridge, except for the Blue Bridge, and other trajectories are exactly the same.

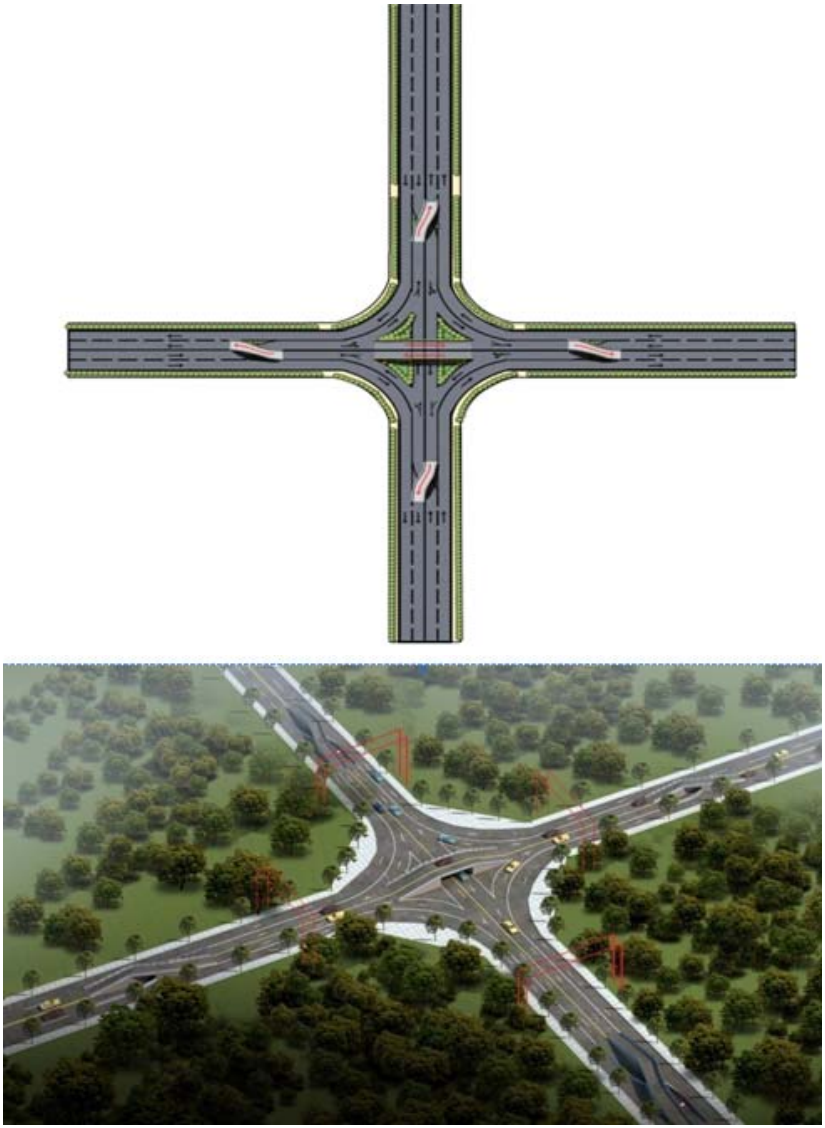

Fig. 2. CAD map after traffic distribution at the crossroads

2.1.3 Designing a T-junction with the cancellation of traffic lights

Fig. 3. The CAD map after the distribution of the T-junction traffic

The T-shaped traffic junction is simpler than the cross-shaped junction. In addition, that does not require passage through the central transport interchange, the trajectory of the course of each entrance turnbuckle is absolutely the same as for a cross-shaped traffic intersection.

2.2 Design principles and key technologies.

1. Determination of the position and length of the external displacement of rotation to the right and the definition of a smooth curve of rotation. The offset position and the length of the turn line to the right are determined on the basis of the estimated speed, the projected traffic volume of the planned year and the environment in the central business district, and so on. in combination with the

position of semi-dug semi-frame bridge supports. The smooth turn curve should be determined in combination of the road class and the requirement of a four-wheel-turn for the vehicle. Usually calculated by the formula l = vd / (kwr). (l: rotary arc, d: distance between the front and rear axles of the vehicle) [4].

2. Determination of the position of the bridge supports of half-opened semi-frame micro interchanges of a mutually communicating type. The position of the bridge supports should be determined in accordance with the distance between adjacent intersections, the length of the intersection that is blocked by road transport, the line of sight distance between vehicles and the minimum distance for parking the vehicle at the edge of the road. The type of bridge must meet the requirements of the load and be combined with the historical and cultural planning of the central business district, corresponding to the nature of the attractiveness of the landscape. The angle of the bridge should be in accordance with national standards.

3. A method for increasing or decreasing the number of strips and determining the length of the width extension (3). Before entering the miniature traffic junction, the roadway must move smoothly outward, compressing the outer lane to add a strip to meet the requirements of the traffic flow above and below the bridge. After the next trestle, the bandwidth must be reduced to approach the split traffic stream. The length of the width extension is calculated according to the formula la = ls + ld, ld = vw * / 3, ls = 10N [5].

4. The principle of many-dimensional functional channeling in plane intersections. To achieve the traffic of the four input lanes at the traffic intersection at the same time, there is a separation in the plane both in the through traffic intersection and during the traffic - there are no signal traffic lights, there is no downtime during unimpeded traffic.

5. Single-lane traffic in the areas of confluence, transverse reverse movement and conveyor traffic. The one-way transversal reverse movement in the intersection zone completely separates the conflict points, while the pipelining of the traffic stream in the intersection zone leads to a significant increase in the traffic flow rate.

6. Early separation and later convergence of the traffic flow with the left turn. Separation of the load of the two main traffic streams allows to evenly distribute the traffic flow in each band and rationally decentralize the traffic volume at intersections, which allows to successfully and evenly eliminate traffic jams between incoming and outgoing vehicles.

7. Complex principle of planning the transport interchange by solving the problem of complex distribution. Satisfaction of the basic requirements of the four-stage approach to planning basic traffic CAD not only fully meets the requirements of current traffic, but also opens channels for the future development of intelligent transportation.

3 Innovative features

1. The use of the method of sewerage (traffic distribution) for planning urban areas of business activity realized the functions of spatial separation and multidimensional traffic of single-level transport interchanges. Traffic distribution allows not only to solve a number of traffic problems caused by the use of traffic

lights, but also receives the opportunities of fully interconnected traffic junctions intersecting in one level, positively solves the problem of congestion in the central business districts.

2. Early separation and later convergence of the traffic flow with the left turn. Today, parallel movement in a straight line and a right turn is more efficient than in a left-turn strip, and the separation of the main traffic stream into two left turns divides the load on the road segment, evenly distributes traffic at traffic intersections, which perfectly matches the bandwidth requirements of various turns in areas of central business districts.

3. Single-lane traffic in the areas of confluence, transverse reverse movement and conveyor traffic. The one-way transversal reverse movement in the intersection zone completely separates the conflict points, while the pipelining of the traffic stream in the intersection zone leads to a significant increase in the traffic flow rate.

4. Elaboration of the principle of determining the position of bridge supports of half-open semi-frame micro interchanges of a mutually communicating type, forming the principle of the added band when the congress is separated from the motorway and proposing the theory of functions of the width of the traffic bridge:

a) The position of the bridge supports should be determined according to the distance between neighboring intersections, the length of the intersection, which is blocked by road, the line-of-sight distance between vehicles and the minimum distance for the pairs ovki vehicle at the roadside;

b) the separation ramp from the motorway is located directly under the micro bridge. The principle of its expansion and addition of roads should be combined with the period of planning the forecasted traffic volume, the class of the band and the conditions for external displacement of the most remote bands with the right turn;

c) Since this calculation bridge has areas with a forward and reverse direction of motion, it is calculated in accordance with the improved waveform AA [6].

Improved wave: $d1 = 1{,}1 + 0{,}043 / 4$ (with the function of improving the border of the side edge), $d1 = 1{,}1 + 0{,}02\ (V1 + V2)\ 3/4$ (reverse direction). The calculated width of the medium is $d2 = M\ (q1 + q2) / (Vp * f)$ (M is the average area modulus, f is the availability factor). The width of the bridge of confluence:

$$d = ad1 + bd2\ (a + b = 1) \qquad (3)$$

d - is an improved function that combines the space of the central business district and the width of the vehicle.

5. Innovative method of machine not separation. Combines the conditions for mixed traffic in China to implement segmented mixing; segmented separation of machines and not machines. As part of this planning, the separation of machines and machines is carried out. The division is aimed at the use of adjacent streets and tracks leading to areas of concentration of non-motorized means, and then movement on direct viaducts or underground passages. In areas significantly removed from planning, a mixed movement of motorized and non-motorized means is carried out [7].

4 Prospects of application (conclusions)

The abandonment of the construction of traffic lights on the overloaded sections of the road at traffic junctions is a complete perfect system with extensive service capabilities and the possibility of implementation. It can provide complex and diverse traffic situations, eliminate congestion and meet the requirements for efficient and convenient traffic in central business areas. It activates commercial, economic and cultural exchanges throughout the region, and the construction sites turn into profit beneficiaries, pours new vitality into the development of a business segment based on transport. As a result, GDP, energy consumption, land use and the environment of the region are healthy, and the economy continues to grow. Nevertheless, the design of traffic separation still has disadvantages in the segments of the separation of motor and non-motor vehicles, communications, end-to-end interchanges, direct and left parallel traffic. It is expected that in the future the researchers will achieve an absolute separation of motor and non-motor vehicles, minimizing the size of through junctions, optimizing overtaking on sections of parallel direct and left-turn traffic.

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