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Optimization Design of Micro-traffic Organization in Urban Intersections

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Abstract

In the city road, the intersection is the bottleneck of traffic flow operation, limiting the operational efficiency of urban traffic. Urban transport, the vast majority of the intersection, the city is essential. In recent years, the number of cars surged, urban road pressure increased, the intersection of more and more become a black spot to control traffic volume. In this paper, near the intersection of the subway construction section, so that the traffic situation is more severe. First of all, the intersection of the investigation and analysis of the intersection of traffic characteristics, including the intersection of traffic lights control phase, control program, the status quo, the import of motor vehicle traffic, pedestrian and non-motor vehicle and their route. And then according to the investigation of the status quo analysis of the reasons for traffic congestion, traffic facilities at the intersection is perfect, the feasibility of channeling, signal timing is efficient. And then according to the analysis from the space and time to optimize the two aspects, so that the intersection of the channel more in line with the custom, with more reasonable time. Finally, the simulation software is used to simulate the design scheme.

Keywords

Plane intersection; annel design; signal timing; VISSIM simulation.

1. Introduction

1.1. The background and significance of the research

The design site is located on Shengli North Street, North Second Ring Road, which is one of the main roads in Shijiazhuang from north to south. Specifically, the entire section from the East Gate Bus Stop of the Railway University to the intersection of Tieyuan North Road. On the west side of the section of Shengli North Street, from south to north, there are 260 Hospital, Shijiazhuang Railway University, Yangtze River Psychological Hospital, Yizhuang Shopping Center, and residential quarters. On the east side are various shops and hotels, attracting a lot of traffic. Since the twentieth century, my country�s highway construction has developed rapidly, especially in order to promote economic development, all parties actively promote the construction of the highway network, but the rapid development of the road network construction has neglected the organization and planning of the use of the road network. . The road network construction is not coordinated with the planning organization, which makes the traffic organization chaotic, the connection between regions is not natural and smooth, the traffic capacity is low and it is easy to cause traffic accidents.

Road network operation is a very complex process involving three aspects: people, vehicles, and roads. The coordination of the three is the key to safe and efficient road operation. In the process of urbanization, the unreasonable operation of the road network will directly affect the development of the regional economy. Therefore, the optimization of traffic organization is crucial to improving the traffic capacity of the existing road network. Nowadays, the impact and social problems caused by traffic congestion in big cities and megacities are becoming more and more serious. Traffic problems have attracted much attention and gradually spread to small cities. The reason is obviously that the rapid economic development, the acceleration of urbanization, the rapid increase in the number of vehicles, and the road as a hardware facility cannot develop in real time according to its needs, and the limited carrying capacity of the road network has led to increasingly serious traffic problems. In urban road traffic, intersections are the nodes of the entire road network, and traffic flows in all directions converge and turn again. Compared with road sections, intersections are more chaotic, prone to accidents, and have low capacity. They are the bottleneck sections of traffic operation. It restricts the speed of traffic flow.

Increasing the traffic flow at the intersection will increase the flow of the entire road trunk. However, in addition to road hardware facilities restricting traffic flow, the rationality of traffic management and control is also an important factor. We generally attribute the cause of traffic congestion to the roads that are not wide enough and the urban structure layout is not reasonable enough, but blindly widening the roads will not necessarily solve the problem. First, the urban space is limited, and the space used for roads has reached the limit and cannot be further widened; secondly, the road width is blindly widened. Unreasonable road width will not only not solve the congestion problem, but may even aggravate the congestion and cause more traffic accidents and pollution. The problem: Finally, for urban construction, the reconstruction or improvement of the road network has a large amount of engineering, high cost, difficulty, and long construction period, which will have a great impact on citizens' travel.

The capacity of the road not only depends on the existing road conditions, but also depends on the way vehicles pass on the road, that is, traffic management and control. Even if the road conditions can satisfy the operation of vehicles and the rules are unreasonable, even if everyone wants to abide by the traffic rules, they will not be able to comply with the rules because they are unrealistic, resulting in unsmooth traffic and causing traffic accidents. Without making large-scale changes to road conditions, real-time improvement of traffic management and control, optimization of traffic organization, compared with road reconstruction, the improvement of management methods is cheaper and faster, not only improving traffic efficiency, but also making roads The traffic is safer. Therefore, in order to improve the traffic capacity of road intersections and promote the effective use of space resources at road intersections, it is particularly urgent to optimize the management and improvement of intersections.

1.2. Status quo at home and abroad

At present, the relatively mature systems abroad include TRANSYT system, SCATS system and SCOOT system. These three systems have their own differences.

The TRANSYT (traffic network study tool) system is a set of programs for offline optimization of network signal timing proposed by the British Institute of Transport and Road Research in 1996. It consists of two parts: simulation model and optimization. It is an offline operation. The timing control system. The simulation model is to simulate the running situation on the road in the signal light control network, and then calculate the indicators of the timing plan; the optimization process is to repeatedly calculate by changing the signal timing plan to find the best plan. In the early days of the TRANSYT system, the phase difference and the green letter ratio were optimized, and only the smallest program index could be calculated in one cycle, but the cycle could not be optimized. For any given timing signal, the corresponding performance index can be calculated according to the known calculation method, and then the green light start time of a certain intersection can be adjusted, and then the corresponding performance index can be calculated. If the performance index decreases, continue to adjust in this direction, if the performance index increases, adjust in the opposite direction until the adjustment reaches the minimum value. The system uses the same method to optimize the green letter ratio of the

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intersection, calculates the performance index of each cycle according to the previously set cycle time, and selects the smallest performance index as the best cycle time. However, the TRANSYT system is an offline operating system and cannot take corresponding solutions to the real-time conditions of the intersection.

The SCATS (Sydney coordinated adaptive traffic system) system was successfully developed by the Australian New South Wales Roads and Transport Bureau in the late 1970s and has been installed and used in Sydney and other cities since 1980. The SCATS system implements overall coordinated control of the overall system including several sub-systems, and implements vehicle induction control locally, that is, while the overall coordinated control, each intersection can be adjusted by vehicle induction control according to their respective operating conditions. The combination of the two makes the control of the whole system more flexible and the operating efficiency is greatly improved.

The SCOOT (splitcycle-offset optimization technique) system is an adaptive control system for real-time coordinated control of the transportation network. It was developed by the British Institute of Transport and Roads in 1973 and used in 1979. The system is developed on the basis of the TRANSYT system, but the TRANSYT system is offline and cannot provide feedback on the real-time operation of the transportation network. The SCOOT system is an automatic solution generation system. The information of the traffic network status is processed online to form a control plan, and the three parameters of green letter ratio, cycle time and green light start time are adjusted in real time to achieve the effect of flexible control. The SCOOT system has special supervision and response measures for traffic congestion. While supervising the traffic operation in real time, it also alarms traffic failures and provides detailed information of each intersection to the staff.

Due to the relatively late motorization process in my country, the research time on traffic flow is not long, and there is a lack of theoretical foundation in traffic modeling and traffic parameter research. Current researches on traffic flow mostly use foreign existing parameters, which are far from the actual traffic conditions in my country. However, a group of scholars who have made outstanding contributions to China's transportation have also emerged in China: Professor Yang Xiaoguang of Tongji University, through investigation and research, obtained the test and data processing algorithms for traffic delays and parking rates at signal-controlled intersections, and traffic lights-controlled intersections with parking lines. Delay simulation algorithm, vehicle delay model and algorithm for traffic light control intersection conflict point, parking rate model before signal light control intersection parking line, research on traffic control signal phase transformation under mixed traffic conditions, and proposed pedestrians on the operation characteristics of mixed traffic flow The signal control setting determines the quantitative model of pedestrian transit time and signal phase. Professor Chen Jun from Southeast University raised the issue of high passenger flow on arterial roads and low public transportation efficiency, which led to congestion. The automatic control system can improve the efficiency of road use. The station is a closed automated ticketing system, and passengers can transfer without leaving the station. Chen Jun believes that the management of congestion should guide people's behavior and habits and optimize the allocation of road resources. Professor Wu Bing�s main research direction is traffic system analysis and optimization design, traffic congestion management and control. In the field of congestion traffic flow management and control technology research, he has studied the characteristics of urban road congestion traffic flow and traffic management and control strategies. Professor Li Keping studied the waiting time of pedestrians at signal-controlled intersections, simulated and analyzed road intersection conflicts, studied the problem of green light interval time in urban road traffic signal control, and extracted the delay parameters of signal-controlled intersections, and gave signal control Real-time delay measurement methods at intersections, research on pedestrian crossing traffic organization and control at signal-controlled intersections, virtual experiments

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on pedestrian crossing behavior at signal-controlled intersections, and dynamic delay measurement methods at unsaturated signal-controlled intersections. Professor Xu Liangjie of Wuhan University of Technology analyzed the operating characteristics of different traffic flows at four-phase control intersections, and obtained non-motorized and pedestrian signal control methods and capacity calculation formulas. Setting special traffic signals for non-motorized vehicles and pedestrians can reduce intersections. Conflict points to improve the safety of the intersection. Scholar Liu Shupeng believes that the capacity of motor vehicles and non-motor vehicles to release bicycles in the same phase at the intersection has not been improved.

The motorization process in developed countries such as Europe and the United States is much earlier than that in my country, so their research on the traffic flow on the road is relatively thorough, but there is a lack of research on the behavior of non-motorized vehicles and pedestrians on the road, and the road exercise rights of pedestrians and motor vehicles are ignored. . The research on transportation in my country started late, the urbanization process in my country is proceeding rapidly, the number of vehicles in the city is increasing rapidly, and the investigation of basic data is very difficult. Insufficient basic data makes it impossible to establish a traffic model that meets the traffic conditions in our country, and the traffic problems cannot be thoroughly solved. The solution.

2. Current Status of Tieyuan North Road Intersection

2.1. Traffic investigation

Before designing, we first conducted a week-long traffic survey at the intersection, collected statistics on the various traffic volumes of the entrance lanes at the intersection, and measured the dimensions of the intersection in all directions.

2.1.1. Traffic volume survey

The vehicle traffic volume of each entrance road at the intersection of Tieyuan North Road and Shengli North Street. The survey time is from 5:40-6:40 on Wednesday afternoon. We have calculated the flow rate of the highest 15min during peak hours. The equivalent data are as follows:

Table 1 Flow direction at the intersection of Tieyuan North Road

Vehicle type	Small passenger car	medium bus	large passenger car	small truck	medium truck	large truck
PCE	1.0	1.75	2.25	1.0	1.75	2.25

Table 2 Motor vehicle flow at the intersection of Tieyuan North Road

Entrance way	Qmn(pcu/h)	Big car rate	qmn(pcu)
NorthImport Straight	1150	0.2	1534
Right	105	0	140
total	1255		1674
South Import Syraight	1218	0.16	1624
Right	96	0	128
Total	1314		1752

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East Import Right	96	0	120

Note: The north-south entrance is the main entrance, and the PHF is 0.75, the east entrance is the secondary entrance, and the PHF is 0.8.

Table 3 Non-motorized vehicle flow at the intersection of Tieyuan North Road

Entrance way	Qmn(Vehicles /h)	Average flow rate (vehicles/min)
North Import	1680	37
South Import	1710	38
East Import	580	12

The survey measured a pedestrian traffic of 340 people/h.

2.1.2. Existing transportation facilities

This intersection is the primary and secondary intersection, the main road, Shengli North Street, the secondary road, Tieyuan North Road, and the bus stop at Tieda East Gate to the intersection of Tieyuan North Road. There are a lot of motor vehicles, non-motor vehicles and pedestrians in this section, which can be "passed" according to the original traffic plan. However, due to the construction of the subway line, the construction section occupies part of the road lanes, resulting in congestion and chaotic traffic on this section.

The main road of this section is a two-way six-lane, separated by a central separation belt, with a motor vehicle lane on both sides and a non-motor vehicle lane on both sides. The width of each motor vehicle lane is 3.5m, each of non-motor vehicle lanes is 5m, and the main and auxiliary roads are separated by a 2m wide partition. The construction section starts from the south entrance of the intersection of Tieyuan North Road to the entrance of the Yizhuang underground garage. It is 255m long and 28.5m wide. It covers an area of 7267.5m2 and directly occupies six lanes of the main road. There are two bus stop signs (one on each side of the road) at 50m on the south side of the construction section. A total of 7 buses stop here. There is a pedestrian crossing zebra crossing, but there are no signal lights to ensure the safety of pedestrians crossing the street. Adjacent to the north side of the construction section is the intersection of Tieyuan North Road. This intersection is the intersection of the main and secondary roads. The main road runs north-south to Shengli North Street and the secondary road. The main road is 44m wide and the secondary road is 6m wide. On both sides of the construction section are two motor vehicle lanes with a width of 2.5m and a non-motor vehicle lane with a width of 2.5m. The intersection of Tieyuan North Road is a signal-controlled intersection. Due to the existence of the construction section, only pedestrians and non-motorized vehicles are allowed to pass in the east-west direction of the intersection. There is a signal light at the exit of the construction section.

The intersection is a signal-controlled intersection with two phases. The north-south phase is for motor vehicles, non-motorized vehicles, and pedestrians, and the east-west phase is for non-motorized vehicles and pedestrians. The phase diagram is as follows:

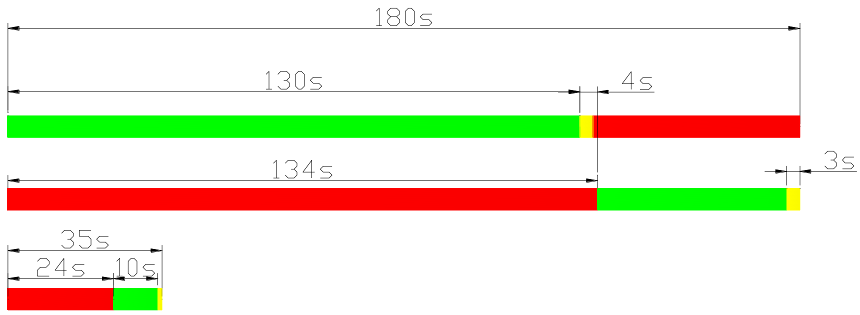

Fig. 1 Two-phase signal timing diagram

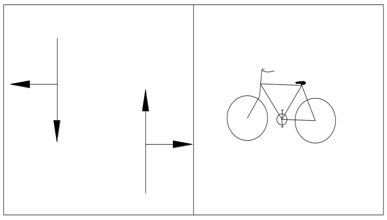

Fig. 2 The current two-phase scheme at the intersection of Tieyuan North Road

2.2. Analysis of the status quo of intersections

2.2.1. Current status of canalization at the intersection of Tieda East Gate and Tieyuan North Road

1. At the intersection of Tieyuan North Road, there are 4 motor vehicle lanes with a width of 3.5m, a non-motor vehicle lane with a width of 4m, and a one-way two-lane motor vehicle lane with a total of 5m and a non-motor vehicle lane 2.5. m. The straight-line distance from the stop line of the entrance road to the entrance of the exit road is about 30m, and the length of the transition section of the confluence is too short. As a result, the traffic capacity at the intersection is reduced, vehicles converge, congestion, and the safety factor at the intersection is reduced.

Optimized plan: set a U-turn exit at the central separation belt 100m upstream of this intersection, and set a main road exit at the separation belt of the main and auxiliary roads, mainly for right-turning vehicles to turn right. At the same time, due to the reduction in the number of lanes in the exit lane, in order to avoid congestion at the intersection, the traffic flow will merge to the two lanes upstream of the intersection in advance to ensure smooth operation of the intersection. The central partition gradually widens to occupy one entrance lane, making the main road three-entry lane change to the second-entry lane, and the width of the lane remains unchanged.

2. There are residential communities on both sides of Tieyuan North Road. There is a large demand for non-motorized vehicles to cross the street. The length of crossing is about 50m. The traffic of non-motorized vehicles during peak hours is 1120veh/h, and the green light time is only 40s. Non-motorized vehicles cannot be in a green light time. All non-motorized vehicles pass through within the road, and some non-motor vehicles are stuck in the middle of the road. When motor vehicles are driving in the green phase, they are waiting for the opportunity to pass through the intersection, which is very dangerous. In addition, non-motorized vehicles are flexible, and their driving trajectories are randomly chaotic, which reduces the traffic capacity of the intersection. The pedestrian flow at this intersection is 340 persons/h pedestrians during

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the peak period. The mixed traffic of non-motor vehicles increases the risk factor and affects the efficiency of bicycle traffic.

Optimized plan: set up a 2m wide pedestrian crossing zebra crossing 0.5m before the stop line of the entrance road, set up a 3m wide non-motorized vehicle lane in front of the zebra crossing, and set up pedestrian and non-motorized vehicle safety islands for pedestrian and non-motor vehicle safety islands by using the space of the lanes to converge. Stay. Standardize the traffic trajectory of crossing traffic, and separate pedestrians and non-motorized vehicles to ensure pedestrian safety and improve the efficiency of non-motorized vehicles crossing the street. Set diversion lines for motor vehicles at intersections so that they can drive along the diversion lines

3. The stop line of the entrance road is just at the edge of the construction site, and the surrounding wall of the construction site is 2m high. Motor vehicles are waiting here. The field of view cannot determine the driving safety ahead, which affects the driver's visual distance and is prone to danger.

Optimized plan: As there is no motor vehicle flow in the east-west direction, the south entrance of the Tieyuan North Road intersection will move the stop line forward 0.5m from the edge of the non-motorized vehicle lane, and add a diversion line in the middle, which is conducive to regulating the driving of non-motorized vehicles. The trajectory also avoids the danger caused by insufficient sight distance. Similarly, at the exit on the south side of the construction site, in order to increase the sight distance, move the stop line forward by one vehicle to increase the sight distance.

4. At the exit on the south side of the construction site, the low parking lot of Yizhuang Shopping Center to the west attracts traffic, and the opposite bus station sign, the east gate of the Railway University, the 260 Hospital, and the Yangtze River Psychological Hospital to the south attract a large number of passengers. There are frequent transfers and there is a great demand for pedestrians to cross the street.

Optimized plan: There are main roads facing traffic flow and pedestrian crossing demand here, with Yizhuang entrance as the exit road, set up an intersection here, and coordinate control with the intersection of Tieyuan North Road. A dedicated left-turn lane is provided for the south entrance of the left-turn traffic flow, and the left-turn substitutes for the turning area.

2.2.2. Current channelization of the intersection of Tieda East Gate and Tieyuan North Road

The section from Tieda East Gate to Tieyuan North Road intersection is abnormally congested, and the key area is lack of channelization. The current channelization map is shown in the figure:

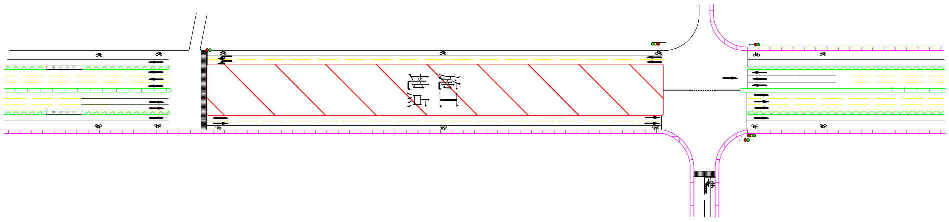

Fig. 3 Current Channelization Map

3. Microscopic traffic organization optimizes channelization design

Through the discussion in Chapter 2, we have a certain understanding of the existing intersections involved in this design. The principles of traffic management and control include the principle of separation, speed limit, dredging, resource conservation, and sustainable development. The key to improving the traffic capacity of this existing intersection is the separation principle, which is to separate the traffic flow in space and time. This chapter mainly separates motor vehicles, non-motor vehicles, and pedestrians in space, that is, channelizes intersections.

3.1. Optimized design of intersection

The optimization design of an existing intersection is to investigate the intersection, including the flow of each entrance of the intersection, the flow of non-motor vehicles and non-motor vehicles crossing the street, the width of the width of each lane, the existing channelization plan, and the signal timing plan. Analyze the current operation situation of the intersection, optimize the channelization and signal timing plan, alleviate conflict points, and make the intersection more efficient and safe. This chapter mainly analyzes the intersection channelization design, and optimizes the timing in the fourth chapter.

3.1.1. Traffic Channelization at Single Point Intersections

The traffic channelization of intersections refers to the installation of intersection signs, markings, and traffic islands according to the various traffic requirements of motor vehicles, non-motor vehicles, and pedestrians at each entrance of the intersection, so that each direction and different types of traffic flow The road passes through the intersection efficiently and safely. The key to traffic channelization is to conform to people's traffic habits, to arrange the right of way in space according to people's psychology of wanting to walk the shortest distance, from the perspective of various types of traffic demand. The purpose of channelization is to divert different flows, clarify the right of way in places that are prone to conflicts, and regulate the route of traffic flow.

The purpose of traffic channelization is to improve the traffic capacity and operating efficiency of intersections on the basis of ensuring traffic safety by setting up signs and markings, traffic islands, and diversion islands. The channelization of intersections has the following principles:

1. Concise and clear, not to confuse or misunderstand the driver;

2. Safe and efficient, to ensure that the driver has enough line of sight to operate safely and efficiently during normal driving;

3. Comply with regulations, and traffic channelization must comply with regulations;

4. The design is beautiful, and the driver feels comfortable during driving.

3.2. Channelization of motor vehicle lanes

3.2.1. U-turn lane channelization of road sections

U U-turn opening is set upstream of the intersection

U-turn openings should be set up upstream of the parking line of the north entrance road at the intersection of Tieyuan North Road. In order to avoid U-turn vehicles affecting the lane merging traffic, a U-turn lane opening should be set on the central separation belt about 3m upstream of the merge start point, with an opening length of 15m. To ensure its safety, speed bumps and yield signs should be installed on the outflow side of the U-turn lane to reduce the speed at which U-turn vehicles enter the exit and warn U-turn vehicles to yield.

U-turn openings are set up upstream of the stop line at the intersection

In order to prevent U-turn vehicles from affecting pedestrian traffic across the street, a U-turn lane opening should be set on the central separation belt about 3m upstream of the parking line at the intersection, with an opening length of 15m, sharing the same entrance lane with a dedicated left-turn phase to realize vehicle U-turning. Similarly, to ensure its safety, speed bumps and yield signs should be set on the outflow side of the U-turn lane to reduce the speed at which U-turn vehicles enter the exit and warn U-turn vehicles to yield.

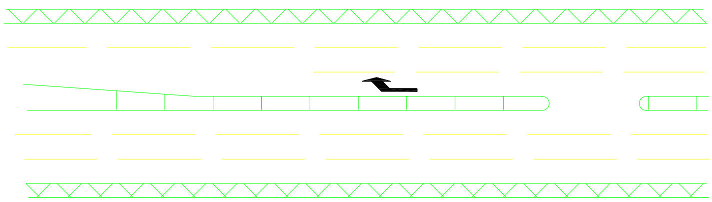

Fig. 3 U-turn export diagram

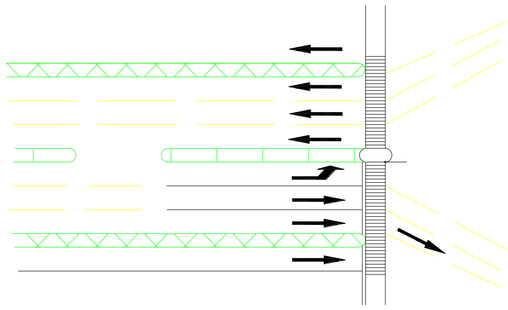

Fig. 4 U-turn export diagram

3.2.2. Channelization of the entrance to the intersection

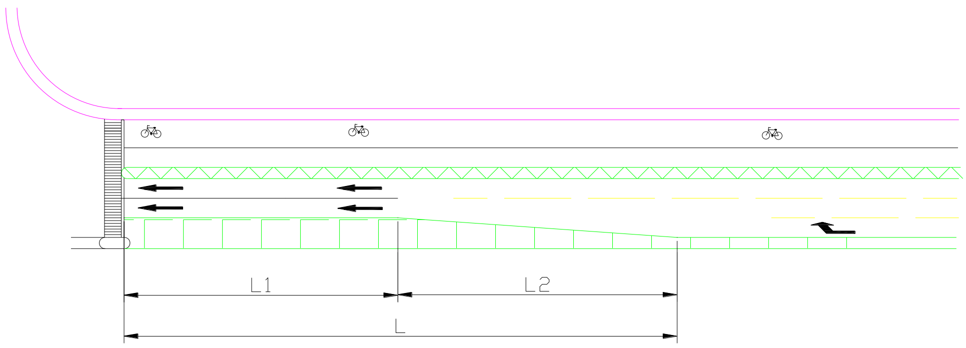

Fig. 5 Lane merge map

The lane reduction section L of the entrance lane is determined by two parts: the transition section L2 and the lane reduction section L1. L1 and L2 are respectively determined by the following formulas:

$L_1=10N$, $L_2=(V\times\Delta W)/3$ (3-1)

V is the calculated driving speed of the entrance road (Km/h);

ΔW: lateral offset (m);

N: The average queue length of left-turning or right-turning cars in each signal cycle during peak hours.

For primary and secondary intersections, the length of the reduced section of the main road is 70-100m, and the length of the transition section is 20-40m.

After calculation, the gradual change section L1=20m, L2=70m.

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3.2.3. Channelization of left-turn lanes at intersections

Because the surrounding area attracts many passengers, there is a large demand for vehicles turning left and parking on the south entrance road and pedestrians crossing the street. Therefore, an intersection is set up at the south exit of the construction site and controlled by signal lights, and coordinated and controlled with the intersection of Tieyuan North Road on the north side. The left-turn waiting mark at the intersection is at the front end of the special left-turn lane at the intersection and extends into the waiting area for left-turning vehicles at the intersection. Setting the left-turn waiting line is in the special phase of going straight first and then turning left. Using the straight-going time period, left-turning traffic can enter the intersection and wait for a left-turning, which is to increase the traffic rate of left-turning traffic. The following conditions are required to set the left turn waiting area:

There is a dedicated left-turn lane at the entrance

There is a special phase for left turn at signal control intersections

First turn the traffic flow straight, turn left into the waiting area, turn left to let go, turn left to flow through the traffic.

Figure 3-4 is an illustration of the left-turn waiting area at the intersection:

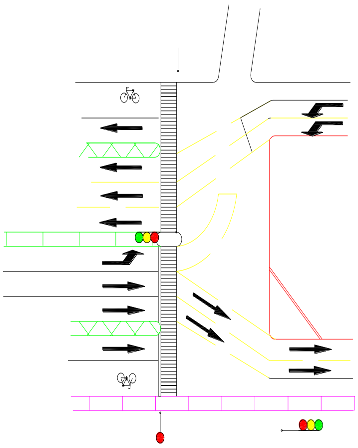

Fig. 6 Turn left waiting area icon

3.2.4. Channelization of the stop line of the entrance lane at the intersection

The position of the stop line of an intersection entrance road is determined by the most unfavorable traffic conditions between the entrance road and the various traffic flows of the adjacent entrance roads on the left and right sides, which directly affects the traffic safety and traffic efficiency of the intersection. The elements to be considered are:

The parking line should be set up perpendicular to the center line of the lane;

When there is a pedestrian crossing, it should be set 1m-2m behind it;

The position of the parking line should not affect the traffic flow in the intersecting road;

The position of the parking line should ensure that the left-turning motor vehicle flows according to the normal trajectory.

In this design, because the subway construction site is 2m high and located in the center of the road, it occupies the entire main road position, which makes the visual distance of the traffic flow on the road insufficient, which is easy to cause danger. Move the two parking lines close to the construction site forward to ensure a safe sight distance. Move the parking line of the south entrance road at the intersection of Tieyuan North Road to the edge of the non-motorized vehicle lane. The parking line for the right-turning traffic flow at the east entrance of Tieyuan North Road is also moved forward to the edge of the non-motorized vehicle lane. It not only satisfies the sight distance requirement, but also regulates the trajectory of non-motor vehicles. The parking line after channelization in this design is shown in Figure 3-5:

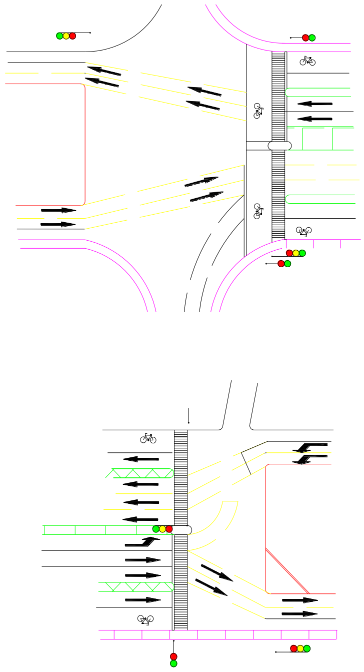

Fig. 7 Parking line setting icon

3.3. Channelization of slow traffic across the street

There are residential areas on both sides of Tieyuan North Road. There are a lot of non-motorized vehicles during peak hours, and the demand for crossing the street is large. Non-motorized vehicles are mobile and flexible. The driving path is random and chaotic. Pedestrians interfere with non-motorized vehicles. The efficiency of non-motorized vehicles crossing the street is reduced, and the safety factor is reduced. The main road has a width of 44m, and it is necessary to set up a crossing safety island at the central separation zone for pedestrians and non-motor vehicles to stop. At the same time, separate pedestrians and non-motorized vehicles and walk in their own way without interfering with each other to improve traffic capacity. The optimized channelization diagram is shown in Figure 3-5.

4. Optimal timing design of micro-traffic organization

4.1. Optimized design of intersection

4.1.1. Traffic signal control at single-point intersections

Signal control at a single intersection is divided into timing signal control and induction signal control. Timing signal control is the most basic control method among various signal controls. In practical terms, it is now the most widely used method due to its simple equipment, the least investment, and convenient maintenance; technically, the basic principle of this control technology is also the basis of other control methods. The basic principle of the point control timing signal is to determine the timing plan of the timing signal according to the channelization of the intersection, the traffic volume of each entrance, and the flow of pedestrians and non-motorized vehicles.

Single-point intersection timing signal timing includes signal phase scheme and basic signal parameters. The signal phase scheme is the allocation of the right-of-way sequence of each entrance. In a cycle, several control states are arranged, each control state has a right-of-way for vehicles and pedestrians in a specific direction, and the display sequence of these signal phases is reasonably arranged. The signal control machine turns on different signal displays

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according to the set phase plan, and gives the right of way to vehicles and pedestrians in turns. At a signal-controlled intersection, each control state, that is, the combination of different light colors displayed in different directions of each entrance lane, is called a signal phase. The phases and sequences of all these signals are collectively called phases, and there are generally two phases and multiple phases. The basic signal control parameters, one is the period length, and the other is the green signal ratio. The cycle duration is the time required for the various light colors of a certain entrance channel to be displayed one time in turn, and the sum of the display times of various light colors; or the green light of a certain main phase starts to turn on again next time the green light A period of time between lights. The signal duration is the key control parameter that determines the traffic efficiency of the timing signal at the decision point, so it is the main object of the signal timing design. The green signal ratio is the ratio of the effective green time of a signal phase to the period of time.

Because this design solution is to set up another intersection on the basis of one intersection, it involves multiple intersection signal lights linkage control. The linkage control of signal lights is to connect several adjacent traffic signals on a trunk road, and coordinate and control them so that vehicles encounter the least green lights when driving on the trunk road, resulting in the smallest traffic delays.

4.2. The basic method and evaluation of timing signal timing

4.2.1. Traffic signal control at single-point intersections

According to the characteristics of my country's urban traffic, the basic method of timing signal timing is:

1. Channelize the designed intersections, which has been described in detail in Chapter 3.

2. Determine the basic scheme of signal phase:

⑴In this design, the signal phase and intersection channelization are set at the same time. If there is a dedicated phase, a dedicated lane must be set. The north entrance of the intersection is newly established. There is a dedicated left-turn phase for left-turning cars. The intersection has a dedicated left-turn lane.

(2) There is a dedicated left-turn lane at the newly established intersection, and the average left-turning vehicle reaches 3 vehicles per cycle, and a dedicated left-turn phase should be set.

⑶The left-turn flow rate of the north entrance of the newly established intersection is 0, so a one-way left-turn dedicated phase should be used.

The left-turn traffic flow at the two intersections in this design is very small, and both adopt the two-phase scheme design

3. Saturation flow calculation

Saturation flow rate is the maximum flow rate that a continuous fleet of vehicles on the entrance road can pass through the entrance to the stop line during a continuous street light time. The unit is pcu/green light hour.

Basic saturated flow of various inlets

Table 3 Non-motorized vehicle flow at the intersection of Tieyuan North Road

Lane	Sbi
Straight lane	1650
Left turn lane	1550
Right turn lane	1550

Note: The width of the entrance is 3.0-3.5m.

⑵Common correction coefficients for all types of lanes

Lane width correction:

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$$f_w = \begin{cases} 1 \\ 0.4(W - 0.5) \\ 0.05(W + 16.5) \end{cases} \tag{1}$$

In the formula: W——lane width, m.

In the designed intersection, the channelization width of the north entrance is WN=3.0, f_W1=1, and the width of the south entrance is

WS=3.5, f_W2=1.

Correction of slope and cart:

$$f_g = 1 - (G + HV) \tag{2}$$

In the formula: G—The road longitudinal slope of Shengli North Street, 0 when downhill;

HV—The high rate of Shengli North Street, here, HV is not more than 0.5.

Take G=0.02 for this intersection, and HV=0.2 for the north entrance.

Therefore, the north entrance road f_gN=1-(0.02+0.2)=0.78;

South entrance road f_gS=1-(0.02+0.16)=0.82.

(3) Saturated flow of through lanes

The traffic flow and the bicycle influence correction coefficient for the newly-built intersection of Shengli North Street are calculated as follows:

$$f_b = \begin{cases} 1 - \frac{1+\sqrt{b_L}}{g_e} \\ 1 \end{cases} \tag{3}$$

5. Simulation evaluation

5.1. Simulation evaluation

Analyze the current situation from the intersection of Shengli North Street and Tieyuan North Road to the east gate of Tieda, re-channelize the existing problems of the road, optimize the timing, use VISSIM software to simulate the optimized intersection, and simulate the actual traffic situation , To evaluate the feasibility of the optimization plan, the simulation diagram of the channelized road is as follows:

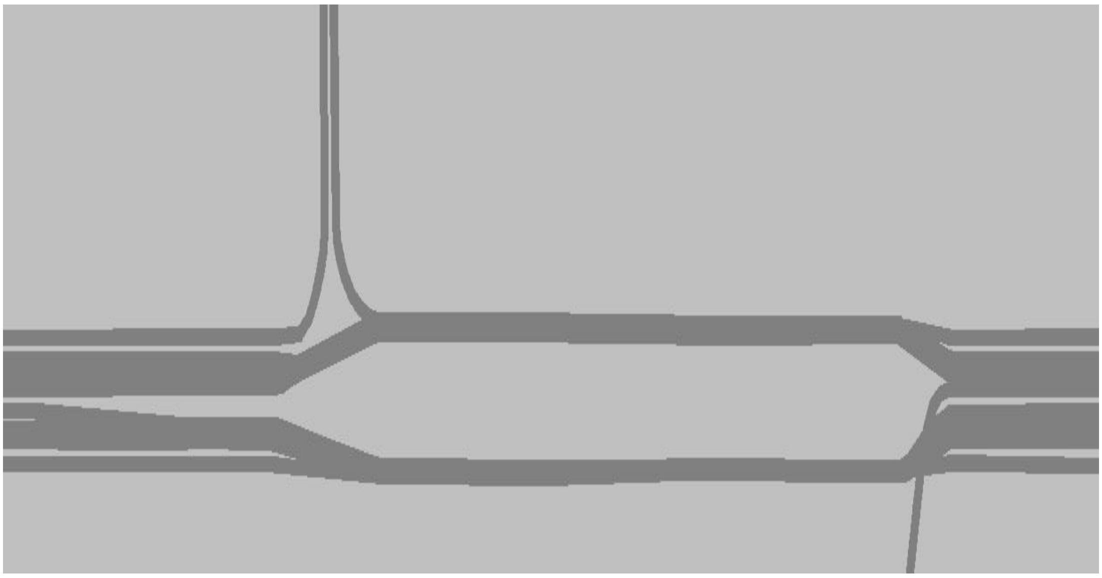

Fig. 8 Schematic diagram of intersection simulation

According to the actual traffic volume survey, a simulation model is set up for the re-channelization plan. The key points of the evaluation are the time when the red light ends and the green light turns on, and the number of vehicles waiting before the parking line, as shown in the following figure:

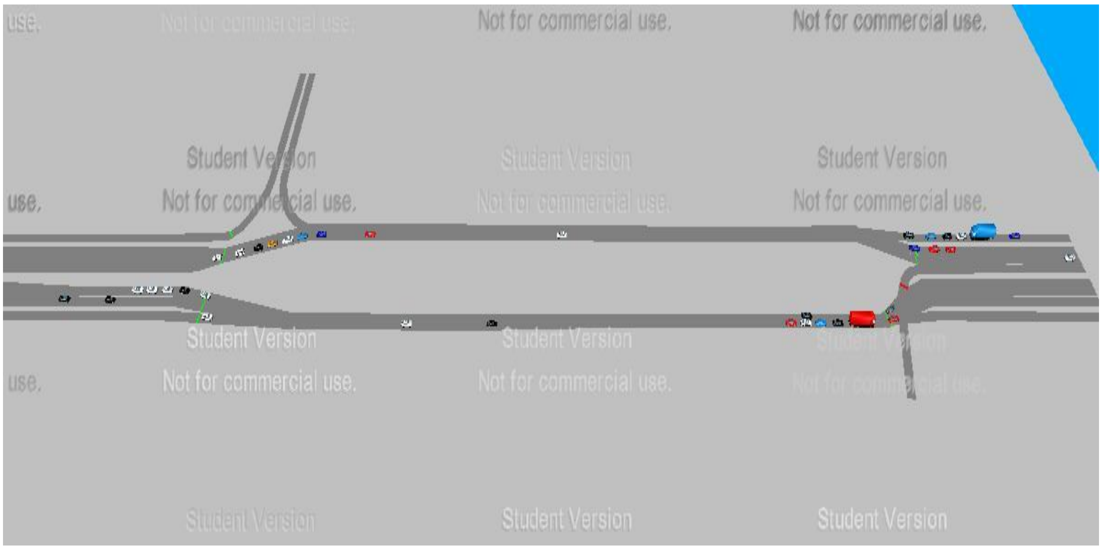

Fig. 9 Schematic diagram of the time when the simulated green light is on at an intersection

It can be seen from Figure 5-2 that at the time when the green light turns on, there are less than 10 vehicles on the construction section before the stop line, which will not affect the start of vehicles on the upstream intersection entrance road. It is found that the traffic flow is running smoothly, and the traffic efficiency is improved compared to before optimization.

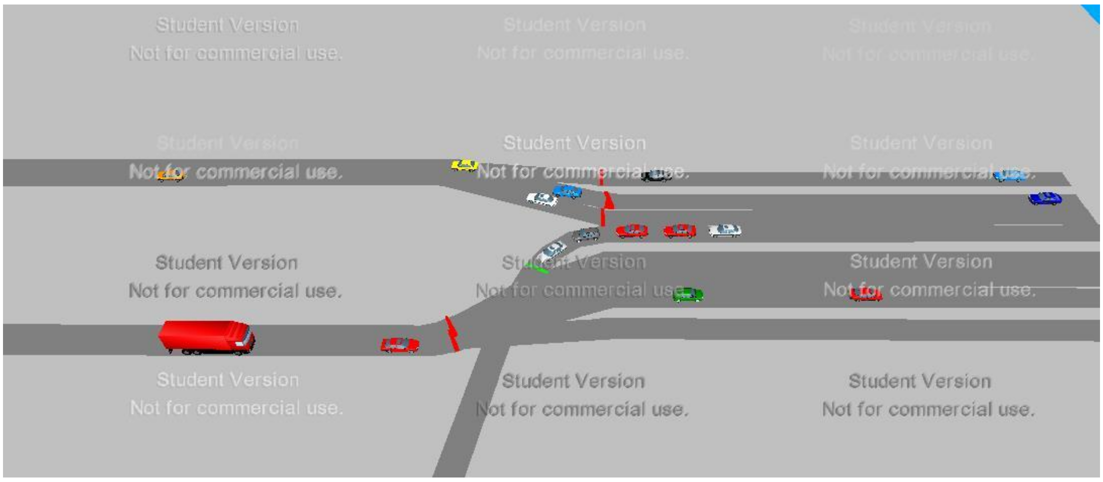

Fig. 10 Schematic diagram of waiting for vehicles when the green light turns left at the intersection

As shown in Figure 5-3, the straight flow of Shengli North Street at the intersection is the main traffic flow. In order to ensure the right of way for the main traffic flow, the weight of the right of way for the left-turn flow is small. The picture shows the left turn traffic phase when the green light turns on. The number of vehicles waiting in the dedicated lane. It can be seen from the figure that the right of way for left-turn traffic is effectively guaranteed, and delays are minimized.

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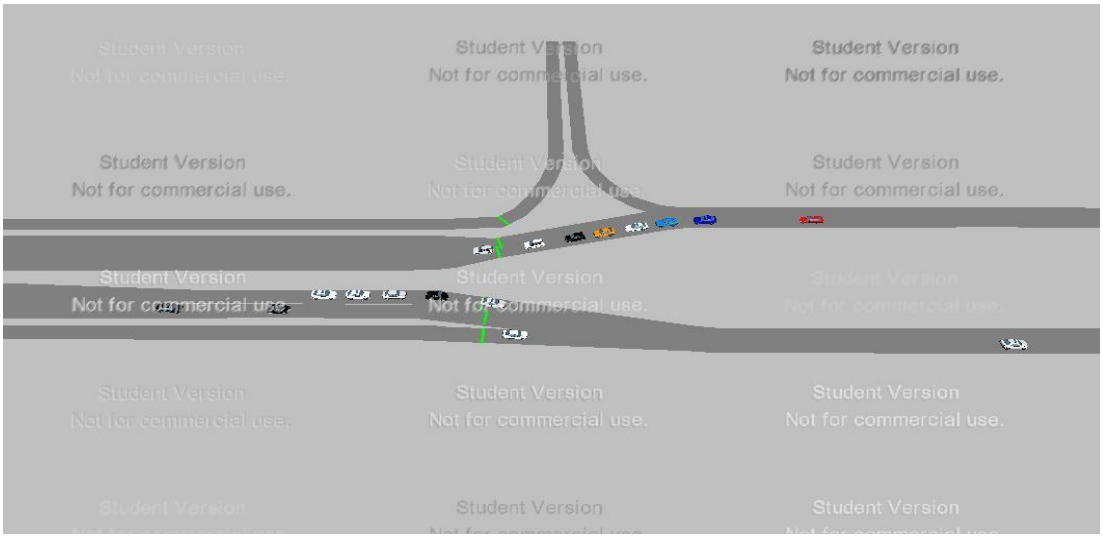

Fig. 11 The north-south green light at the intersection of Tieyuan North Road turns on and waits for vehicles

Figure 5-4 shows the number of vehicles waiting for the north-south green light at the intersection of Tieyuan North Road. There is no east-west interference to the traffic flow at this intersection. The improvement is mainly for channelization and standardize the traffic trajectory of various types of traffic. When the simulation is running, it can be seen that the channelization scheme has effectively alleviated traffic congestion and improved traffic efficiency.

6. Summary outlook

6.1. Main results and conclusions

This design separates the traffic flow in time and space. Based on the discussion of various traffic flow characteristics at the intersection, combined with the actual situation of the Tieyuan North Road intersection, the intersection channelization measures and signal control optimization plan are discussed in detail. Use VISSIM software to view the optimization effect.

6.1.1. Main results

1. Conduct traffic surveys on existing intersections. The survey site is the intersection of East Gate of the University of China Railway University and North Tieyuan Road. The traffic volume, pedestrian volume and non-motorized vehicle volume of each entrance road; the width of each entrance road, central separation belt, and machine non-separation belt.

2. Analyze the existing problems at the intersection. The subway construction of this section occupies the main lane of the road, causing abnormal congestion at the intersection, a large number of pedestrians and non-motor vehicles crossing the street, and the lack of road canalization signs and markings.

3. Propose solutions to existing problems. Separate the traffic flow in time and space according to the problem, evacuate congestion, separate conflict points, and clarify the right of way for all kinds of traffic flows.

4. Carry out simulation evaluation on the optimization scheme. Using VISSIM software, combined with the research results, design a simulation analysis program. Observe that the timing setting is reasonable, there are few waiting vehicles at the beginning of the green, all red can clear the intersection, and the setting of the waiting area has little impact on the road capacity.

6.1.2. Main conclusions

The traffic flow at different intersections has different characteristics. First, it is necessary to understand the traffic characteristics of the existing intersections and analyze the causes of traffic jams and delays. For the optimal design of intersections, the main purpose is to separate the traffic flow and reduce or eliminate the number of conflict points. Generally, the traffic flow is separated in space and traffic flow is separated in time. The spatial separation of traffic flow is mainly through channelization design. Channelization should make maximum use of the existing traffic facilities at the intersection, and relocate unreasonable areas at the intersection based on the principles of safety, efficiency, and simplicity. The channelization of different traffic flows should be mutually exclusive. Cooperate, channelization facilities can not hinder all kinds of traffic flow; the separated traffic flow in time is mainly controlled by signal lights, and traffic timing is one of the keys to signal control. This design uses the Webster timing method for timing.

6.2. Outlook

Due to my limited level and time, there are still many shortcomings in this article. The next step of the research should start from the following aspects:

1. Establish a traffic model suitable for the intersection. The Webster timing method differs from the actual situation of this intersection to a certain extent, and has great limitations. Today, a traffic model consistent with the research intersection should be established, so that traffic problems can be solved more effectively.

2. The traffic survey at this intersection is not comprehensive enough. Due to the limited time and manpower of the survey, there is a certain gap between the actual operation of the intersection and the survey results. In the future, a more comprehensive survey method should be adopted to thoroughly understand the traffic operation at the intersection.

3. Slow traffic settings. In this design, there are many discussions on motor vehicles, and there are some inappropriate points in the treatment of non-motor vehicles and pedestrians. In the future, we will focus on solving the problem of slow traffic.

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At the same time, I would also like to thank the scholars cited in this paper for their monographs. Without the enlightenment and help of the research results of these scholars, I would not be able to complete the final writing of this paper. At this point, I also want to thank my friends and classmates, who gave me a lot of useful materials during the process of writing my thesis, and they also provided enthusiastic help in the process of formatting and writing the paper! no one is perfect. Due to my limited academic level, there are inevitably shortcomings in my paper. I sincerely ask all teachers and classmates to criticize and correct me!

References

[1] Li Xinxing. Design and simulation of control plan for multiple intersections on urban roads [J]. Technological Innovation and Application, 2016(36): 1~3

[2] Su Chunmin. Case analysis of urban road roundabout to cross road intersection [N]. Journal of Beihua University, 2016(03)

[3] Liu Yadi. Discussion on Optimal Design of Traffic Organization at Urban Road Intersections [J]. Jiangxi Building Materials, 2016 (07): 15-20

[4] Yu Qihang, Yang Tao. Design of road intersections in foreign cities [J] . International City Planning, 2009(05)

[5] Du Wanli. Refined planning and optimized design of urban road intersections[J]. Jiangxi Building Materials, 2016(18)

[6] Hu Yongju, Shi Junqing, Tao Yuqiang and Liu Jinli. Research on the capacity of urban road intersections [J]. Journal of Zhejiang Normal University, 2015(38)
[7] Zou Jing. Research on Traffic Organization and Channelization Design of Urban Road Intersections [A]. Transportation Construction, 2016
[8] Liu Ziming, Zhang Meng. Policies to deal with urban congestion from the perspective of institutional economics[J]. Urban Development Theory, 2016(4): 301~304
[9] Li Shuo, Li Ling, Li Ang. Research on delay model of right-turning vehicles under the influence of pedestrian flow at signal-controlled road intersections[J]. Journal of Natural Science of Xiangtan University, 2015, 19(3): 1~6
[10] Yang Fei. Research on Traffic Operation Organization at Level Intersections [C]. Journal of Science & Technology Economics, 2016(33): 88~93