Evaluation on Traffic Guidance Plan during Construction Period based on Vissim Simulation

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***Abstract*—With the urbanization process speeding up, the construction of City Road increased rapidly. So limited road resource is often occupied during the road construction, which makes road capacity of construction affected area greatly decrease. Then the contradiction of city original transport supply becomes more prominent. Therefore, it is very important to make a reasonable traffic organization plan. At first According to the present traffic investigation and construction site management program, combining with the OD（Origin - Destination） distribution principle, the traffic impact of construction section is analyzed, the scope of influence is determined. The Taihangshan Road of Qingdao No.1 subway line is taken as an example, three evaluation indicators, such as: average delays, queue length, number of vehicles between OD points are selected combined with current traffic flow. The available traffic guiding schemes include temporary widening of roads, traffic management measures and construction safety guarantee measures, and so on. Then VISSIM is used for the guidance measures simulation. Finally, According to the simulation results, quantitative guidance measures are evaluated. The choice of reasonable conduct measures is based on relevant data.**

Keywords-Traffic impact; OD distribution; Traffic Organization Plan; VISSIM Simulation; guidance measures

I. INTRODUCTION

Urban road is the main component of urban overall planning, with the rapid development of China's economy, the process of urban construction is speeding up. In order to promote urban development, urban road construction projects Such as road widening, subway construction, pipe lying are also increasing. The construction brings great pressure to the city traffic, and the big cities are more obvious.

In foreign countries, attention has been paid to the study of road maintenance operation and maintenance work area safety [1-2]. Most cities in China focus on the planning of artery in road network planning, Lack of attention to lower grade roads. There is not much research on intersections at construction stage. But many large construction projects, such as the construction of subway stations and viaducts are located near the intersection which lead to a decrease in traffic capacity of construction sections and intersections [3-4]. Road construction has a great influence on its residents' travel and traffic, especially the urban rail project with larger construction time and larger occupation area has more influence on it [5].

With the domestic experts and scholars on the traffic characteristics of the construction area of theoretical research, Construction area specifications and traffic guidance program design need to be further improved.

The Taihangshan Road of Qingdao No.1 subway line is taken as an example, the road and intersection traffic guidance scheme during the construction is explored, and Evaluate by Vissim simulation. It provides a basis for rational selection of traffic guiding scheme.

II. TRAFFIC IMPACT ANALYSIS DURING CONSTRUCTION

Within the scope of construction, the roads are mostly the main roads, and the traffic flow is relatively large. The speed and characteristics of motor vehicles, non-motorized vehicles and traffic flow are different because of the different traffic flow structure of expressways, main roads, secondary roads and branches [6].Construction takes up some sections of the road to reduce its traffic capacity, and the traffic pressure of the surrounding road network increases. Through the analysis of the changes of OD distribution during construction, the quantitative evaluation was carried out with Vissim simulation.

A. OD distribution principle

According to Wardrop's first principle, when the users of the road know the traffic state of the network exactly and try to choose the shortest path, the network will reach a balance

state. If there are a lot of roads between OD, and traffic between OD is very small, the vehicle will obviously walk along the shortest path. With the increase of traffic volume, the amount of traffic on the shortest route will increase accordingly. After increasing to a certain extent, the shortest route will travel longer because of congestion, and the shortest path will change. The vehicle will choose the road with shorter travel time, and as all traffic between OD continues to increase, all roads between OD are likely to be utilized [7-8]. If all the way users know exactly the roads needed to travel time and travel time of the shortest path, during construction as part of road traffic diversion needs, give full consideration to measures to guide traffic, the travel times between the points on the OD will be equal.

In 1956, Beckmann proposed the Wardrop principle to describe the traffic equilibrium assignment and created a mathematical programming model. It was not until 1975 that the Frank-Wolfe algorithm was designed by LeBlanc and other scholars to solve the Beckmann model [9]. But the arithmetic of mathematical analysis is too complex. A method of investigation - simulation analysis is used to parse the traffic between the OD.

B. Range analysis of traffic impact

The construction area makes the traffic environment worse, and the construction related signs, marking; channelization facilities; obstructions and construction vehicles are generally set up. In order to ensure the safety of pedestrians, traffic safety and construction workers, The construction area is divided into six traffic control areas: Warning area, upstream transition zone, buffer zone, work area, transition zone and termination area, As shown in Fig. 1.

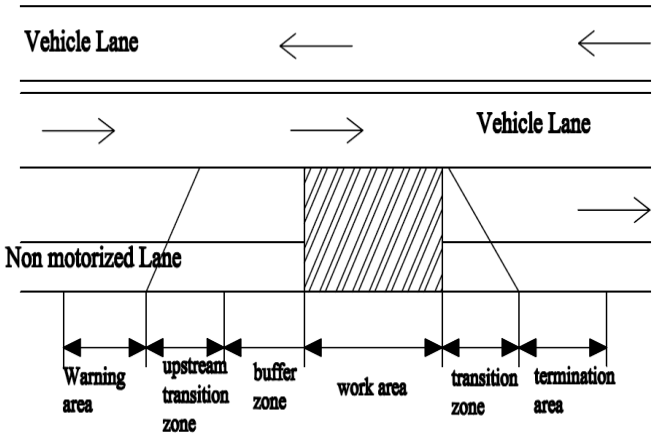

Figure 1. Sketch Map of traffic influence area

There are both objective and subjective factors affecting the determination of traffic impact in construction stage. Warning area is to remind the driver in front of the first stage of construction. The length of the warning area is closely related to the influence area. In the warning area, traffic flow gradually changes from free flow to restricted flow [10]. Length of warning area is shown in Table Ⅰ.

TABLE I. LENGTH OF WARNING AREA

Speed (km/h)	Length of the warning area (m)		
	Single lane	two-lane	Three-lane
80	187.5	375	562.5
60	140.6	281.3	421.9
40	38.7	77.4	116.1
20	9.7	19.4	29.0

Different engineering and technical personnel believe that the scope of the impact may be different. Taking into account the length of the six areas of the building, the scope of construction is suitable for 1000 meters on both sides of the construction line. After determining the scope of the impact, it is necessary to determine the enclosure scheme according to the scope of the construction. The influence of different block schemes on road traffic is different.

C. Vissim simulation

Traffic simulation object is a dynamic traffic system composed of human, vehicle, road and environment. The system is stochastic, dynamic, open and complex. Vissim is a microscopic, simulation modeling tool based on time interval and driving behavior, which is used for traffic modeling of urban traffic and public traffic. Various traffic conditions, such as lane setting, traffic composition, traffic signals and bus stations, can be analyzed.

Vissim simulates traffic flow by moving the "driver-vehicle- unit" in the network [11]. The utility of the model is an effective tool for evaluating the transportation organization scheme and the urban planning scheme. Through the Vissim simulation, the traffic impact during construction is analyzed, and the traffic flow condition after the improvement measures are compared, and the traffic guiding scheme is evaluated, which can effectively organize traffic flow. Three evaluation indicators, such as: average delays, queue length, number of vehicles between OD points are selected in the article. Simulation analysis is carried out to select the better traffic guidance plan.

III. SIMULATION RESULT ANALYSIS

The Yangtze River Road is a main road in Huangdao District of Qingdao City, east of Shaoshan Road, West to the Taihangshan Road. It is an important transportation link between East and west of Huangdao. Taihangshan Road is a main road in Huangdao District, north to Jia Lingjiang Road, South to Lijiang West road. It is a main artery connecting the north and the South. Its intersection is three phase intersection; its intersection is the three phase intersection, which is greatly affected by the construction of Qingdao Metro Line 1.

The early traffic peak on normal working days was selected, and the intersections of rail transit construction were observed continuously. Data obtained through traffic surveys are as follows:

TABLE II. SURVEY OF EARLY PEAK TRAFFIC FLOW

Flow direction	Taihangshan road (pcu/h)	Lushan road (pcu/h)
north -South	1262	845
South- north	965	617

The data acquisition points are set up at each entrance of the intersection, and the number of vehicles needed for simulation is mainly collected. The signal timing diagram is shown in Figure 2.

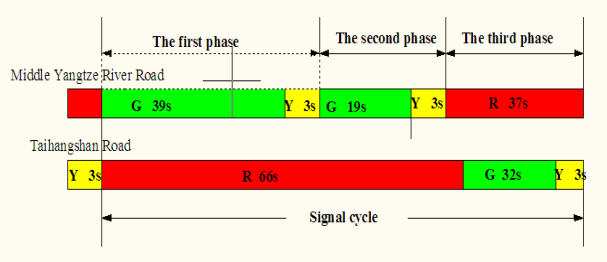

Figure 2. Diagram of Signal timing

The simulation time is three signal cycles, or 303 seconds. By setting up different traffic guidance schemes and Vissim simulation, the average delay and queue length, number of vehicles between OD points is compared; the optimal traffic guidance measures are selected.

A. *Widen the road temporarily, and increase the left turn lane at the intersection (scheme 1)*

According to the principle of "one for one", the " Lushan road" is changed into "two-way six lanes". Make the vehicle turn left at the intersection of middle Yangtze road and Taihangshan Road ahead of time, and the Traffic flow pressure is reduced in construction section. Survey shows Lushan road has expansion conditions. Lane 3 of the entrance of middle Yangtze road and Lushan road is changed to left turn lane, as shown in Figure 2.

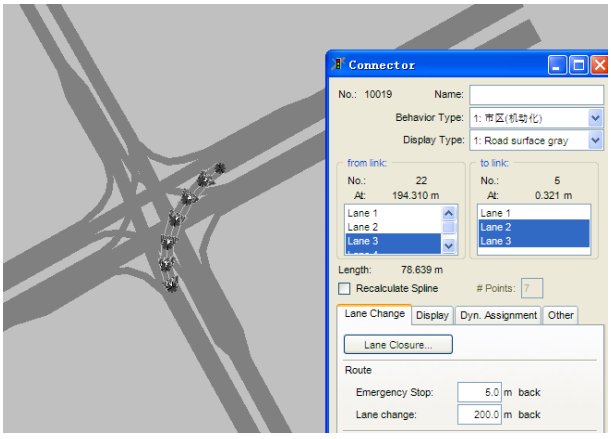

Figure 3. Sketch Map of left turn lane

Before and after measures are taken, the changes of relevant indexes are shown in table

TABLE III. IMPROVEMENT BETWEEN BEFORE AND AFTER

Detection point	Average delay(S)		Queue length(pcu)		Number of vehicles between OD points(pcu)	
	Before	After	Before	After	Before	After
1	39	31	13	8	102	70
2	46	40	15	10	111	78
3	40	35	8	6	85	60
4	41	33	7	5	75	50

In the table, Section 1 is the entrance of the West Yangtze River Road, Section 2 is the entrance of the southern Taihangshan Road, Section 3 is the entrance of the Middle Yangtze River Road, Section 4 is the entrance of the northern Taihangshan Road, as shown in Figure 3.

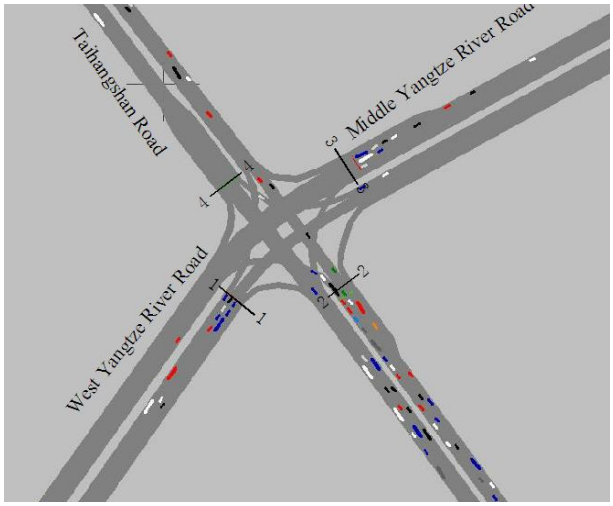

Figure 4. Sketch Map of Monitoring section

B. *Set up diversion island for traffic guidance (scheme 2)*

Guided by the optimization of the intersection, the diversion island can be designed in order to improve evacuation efficiency. The optimal design of the intersection diversion island is mainly to reduce the influence of right turn vehicles on the straight and left turn vehicles. In order to remind the driver to bypass the construction intersection, the number of vehicles entering the construction intersection will be reduced at the two intersections. The contrast results are shown in Figure 3.

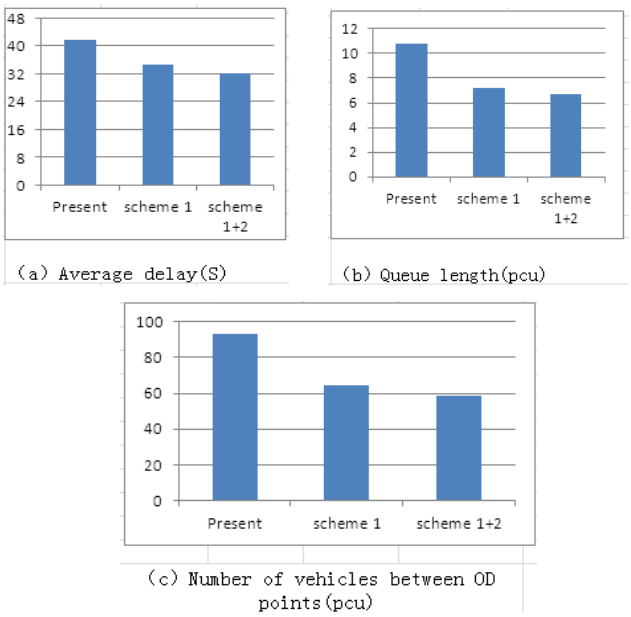

Figure 5. Indicators change chart between before and after

According to the Vissim simulation, after the traffic guidance plan 1 is set up, the average delay of the intersection decreased by 16.3%，queue length decreased by 32.6%, number of vehicles between OD points dropped by 30.8%. After the traffic guidance plan 1and 2 are set up, the average delay of the intersection decreased by 22.3%，queue length decreased by 37.2%, number of vehicles between OD points dropped by 37.0%. At the same time, the traffic volume in the construction area was partially reduced by inducing ahead of schedule. The local traffic pressure caused by road construction has been alleviated, and the smoothness of the road has been improved. Meanwhile, the demand for the modernization of the city has been guaranteed.

Finally, the scheme 1+2 is chosen as a reasonable scheme. Effective improvement measures are adopted, which makes the evacuation of vehicles more rapid. However, the choice of the scheme is only based on traffic facilities, Safety facilities are not considered. In the process of actual selection, safety measures should also be taken into consideration, and the influence of comprehensive evaluation plan should be considered.

IV. TRAFFIC GUIDANCE MEASURES ANALYSIS

During the construction of the road, a part of the urban road will be temporarily occupied, and the cross section and intersection of the road will be affected by the construction, Which will caused Vehicles cannot be in accordance with the original order of normal driving. Therefore, it is necessary to optimize the traffic flow in the construction area. The main optimization methods are: traffic management measures, road traffic diversion and intersection channelization design. In addition, attention should also be paid to construction safety measures.

A. *Traffic management measures*

Traffic guidance is a relatively flexible traffic management intention, and the essence is to implement traffic management strategies by issuing road information. Traffic diversion is a relatively rigid traffic management measures, and it is the process of guiding traffic flow into the designated shunt path by means of traffic channelization [11]. Traffic control is a mandatory means of traffic management. It is an administrative act to force travelers to drive traffic managers. The Vissim simulation is applied to set up the shunting lane and set up traffic guidance. Through the use of two guiding schemes, the average delay, queue length and number of vehicles between OD points, are fell by about 1/3, the improvement effect is obvious.

B. *Construction safety measures*

Road construction safety signs including road construction, road closed (left and right middle road is closed, closed, closed) to the left (right) diversions, slow vehicles etc. Road construction signs are located at the front of the work area. Road closures and road diversions are indicated after road construction signs. If the road is fully closed, the road closure and detour signs are used in combination with the traffic closure signs, and the specific bypass lines are adjusted with the actual road conditions.

TABLE IV. ROAD SAFETY AFTER ADDITIONAL CONSTRUCTION SAFETY MEASURES

Evaluating indicator	**Average delay(S)**		**Queue length(pcu)**		**Number of vehicles between OD points(pcu)**	
	Before	**After**	**Before**	**After**	**Before**	**After**
Index value	41.5	40.75	10.75	12.25	93.25	95.75
Fluctuation	Decline 1.8%		Increase 14.0%		Increase 2.7%	

Construction safety setting is mainly to ensure the safety of construction personnel and road users. According to Vissim simulation, after setting up the construction safety settings, the traffic flow improvement effect is not obvious. It can even result in an increase in the queue length and the number of vehicles between OD points. But in order to ensure safety, construction safety measures must be set.

V. CONCLUSIONS

In order to effectively alleviate and reduce the negative impact of road construction, it is very important to study the optimization design of traffic organization during construction [12]. Through the analysis of the traffic status of the road and intersection during the construction of the subway station, the quantitative evaluation and analysis of the traffic guiding measures are carried out by means of computer simulation. Evaluation indexes such as average delays, queue length, number of vehicles between OD points are selected. Taking into account the construction safety measures, through the construction of traffic flow before and after the Vissim simulation, the optimization effect is analyzed.

According to the quantitative evaluation of the improvement measures, the conclusion is obtained: for the operation safety and management of vehicles, traffic routes are selected for different sections and intersections in the construction area. Not only to ensure the efficiency of traffic, but also to ensure safety in construction. Vissim simulation is used to evaluate the traffic guidance scheme, and the quantitative evaluation indexes can be obtained. However, it is important to note that during the simulation process, road and traffic flow parameters must be set correctly; otherwise it is possible to draw conclusions that do not conform to reality.

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