Traffic Organization Optimization of Renmin Road and Tanan Road Intersection in in Jiaozuo City

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Abstract. This paper takes the intersection of Renmin Road and Tanan Road in Jiaozuo City as an example and carries out traffic organization optimization, evaluating its service level by calculating the capacity, saturation and saturation flow rate, while finding out the optimized timing scheme according to Webster method and equivalent traffic volume method, and conducting traffic simulation with VISSIM to analyze its before and after optimization with queue length, delay and number of stops as evaluation indexes.

Keywords: Traffic organization optimization; VISSIM; Webster method

1 INTRODUCTION

Along with the fast growth of city building and society., the problem of urban road transportation is becoming more and more serious. Research on interchanges plays an important role in increasing city transportation efficiency and decreasing congestion[1].Zheng et al., used a constraint to restrict the use of the imported lanes[2].Along with the expansion and complexity of the highway transport system, the number of crossing points has also become more and more frequent, so has the traffic flow[3].This paper intends to use VISSIM micro-simulation technology as a tool. The traffic scheme and its optimal scheme of the research object are collected and analyzed. The simulation software selected above is used for simulation analysis. Based on traffic delay, queue length and other indicators, the corresponding evaluation model is established, and the current intersection traffic operation status is evaluated accordingly.

2 CURRENT TRAFFIC SURVEY

2.1 Geometric Conditions of Intersections

Tanan Road is a traffic trunk line from south to north, and a special fast bus channel is set up on its road. Renmin Road is a road from east to west.The two roads connecting the north and south of the urban area are the main hubs for a great stream of people

G. Chen et al. (eds.), *Proceedings of the 2024 International Conference on Rail Transit and Transportation (ICRTT 2024)*, Advances in Engineering Research 254,
https://doi.org/10.2991/978-94-6463-610-9_19

and vehicles in the urban area.The intersection of Renmin Road and Tanan Road is a two-way road with 8 lanes. The east-west direction includes a bus lane, two-lane and two-left lane. All exit lanes are 3 lanes, one of which is a bus lane running east and west and two of which are straight lanes.The exit lane is 3 lanes. The red line width of the east-west import road is 70 m, with a total width of 45 m.

2.2 Phase Plan and Timing of Crossing Signal

Based on the site survey,it is found that there are 4 stages in each stage, and the 1st stage runs from east to west.The second phase turns left; the third phase is north – south straight; the fourth phase north – south left turn. The timing of the signal phase is illustrated in Figure 1.

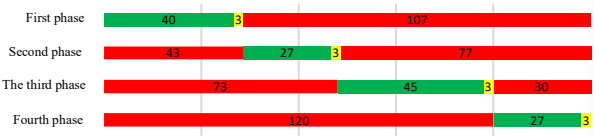

Fig. 1. Present time schedule for Renmin Road and Tanan Road.

3 TRAFFIC ANALYSIS OF INTERSECTION AND ROAD SECTION

3.1 Traffic Capacity and Saturation Analysis

Overview of Traffic Capacity.

(1) Utilization of Interchange Capacity in Traffic Engineering.

$$C_s = \frac{3600}{T}\left(\frac{t_g - t_0}{t_i} + 1\right)\phi \tag{1}$$

In the formula, C_s is a Straight Lane Design Capability;T is the signal light cycle;t_g is the time of the green light for the week of the signal;t_0 is the time after the green light is switched on, and the first car begins and goes across the parking row. 2.3s can be used ;t_i is the average time of straight or right vehicles passing through the parking line;Φ is the reduction factor, available 0.9.

(2) Because there are special left and right corners in the intersection lane :

$$C_{elr} = \sum C_s / \left(1 - \beta_1 - \beta_2\right) \tag{2}$$

In the formula, C_{elr} is the access lane construction capability.;$\sum C_s$ is the sum of the designed capacity of the direct lane ; $\beta_1\beta_r$ is the ratio of left and right transfer vehicles to vehicle in entrance road.

(3) Check if $C_{le} > C'_{le}$ needs to be decreased,the formula is:

$$C_e^{'} = C_e - n_s \left(C_{le} - C_{le}^{'} \right) \tag{3}$$

In the formula, C'_e is the entry's design ability reduced ;n_s is the number of different flat tracks on a surface ;C'_{le} is the number of left turn cars on the other side that does not decrease the design capability of each type of road on this side.

Overview of Saturation Analysis. Saturation X is the ratio of real traffic flow to the saturated capacity of the traffic flow[4]. The calculation formula is :

$$X = \frac{V}{C} \tag{4}$$

In the formula: V is the maximum traffic volume; c is the maximum capacity.

Traffic Capacity and Saturation Calculation Analysis. Based on this calculation, the integration figures are presented in Tables 1 and 2.

Table 1. Traffic capacity of each import

	North import	West import	South import	East import
Peak period	1378	1369	1594	1568
Pingfeng period	1171	1469	888	1229

Table 2. Saturation analysis of each import

	North	West	South	East	Total
Peak period	0.58	0.96	0.56	0.93	0.81
Pingfeng period	0.48	0.66	0.35	0.54	0.64

From the above table, Renmin Road and Tanan Road East-West entrance straight at any time, the saturation is higher than other directions.By analyzing the reasons, it is speculated that the traffic volume is large because the people 's road is the main road ; the saturation of the right turn direction of the north entrance road is also high, probably because the Dennis Mall is on its right side, and there are more citizens who come to shopping and entertainment.

3.2 Road Section Capacity

After modification of the model, we get the design capability of the highway segment[5]. That is:

$$N_a = N_O \times \gamma \times \eta \times C \times n^{'} \tag{5}$$

In the formula:$N_a$is a one-way route design capacity;γ is the adjustment factor for the effect of the bike;ηis a correcting factor for lane width effect; n′is the lane number correction factor; Cis the adjustment factor of intersection influence.

According to calculation, the volume of the road segment is 2549 (pcu/h).

4 INTERSECTION AND ROAD SECTION OPTIMIZATION

4.1 Intersection Signal Control Optimization

Idea : Use Webster 's method

①Overall signal waste time :

$$L = \sum_{k} \left(L_s + I - A \right)_k \tag{6}$$

In the formula, L is the overall lost time of the signal;L_s is the startup time of the car; I is the period of green light ;A is yellow light time;K is the each cycle interval several green lights

② Total flow

$$Y = \sum_{j=1}^{j} max \left[y_j, y_j, \ldots \right] = \sum_{j=1}^{j} max \left[\left(\frac{q_d}{s_d} \right)_{j,} \left(\frac{q_d}{s_d} \right)_{j,} \ldots \right] \tag{7}$$

In the formula,Y is a total of a maximum flow rate y_i for every signal phase forming the cycle;j is each of the signal phases that constitute the period ;y_j is the phase flow ratio ;q_d is the design flow rate ;S_d is a saturation flow design.

③Optimal Signal Cycle with Minimum Delay of Vehicle :

$$C_0 = \frac{1.5L + 5}{1 - Y} \tag{8}$$

④Total effective green time per cycle :

$$G_e = C_0 - L \tag{9}$$

⑤Green time of each phase :

$$g_i = \frac{y_i}{Y} \left(C_0 - L \right) \tag{10}$$

⑥Time for every Stage Green Light after Optimizing :

$$g_i = g_{ej} - A_j + l_j \tag{11}$$

Through the above calculation method,calculation of the green light-time for every phase following the optimization, as illustrated in Table 3..

Table 3. Green time of each phase after optimization

	First phase	Second phase	The third phase	Fourth phase
Peak period	34	16	36	17
Pingfeng period	36	5	30	7

5 VISSIM SIMULATION AND EVALUATION

Using VISSIM Simulation Platform, Optimum Crossing is simulated.The VISSIM results are organized into the following table. Table 4,Table 5.

Table 4. Delay data before optimization

Entrance road	Queue length	Vehicle delay	Parking times
East import	36.81	36.91	0.64
West import	47.65	33.31	0.71
South import	33.31	52.51	0.84
North import	32.16	47.64	0.7

Table 5. Optimized delay data

Entrance road	Queue length	Vehicle delay	Parking times
East import	28.79	33.63	0.6
West import	30.98	40.4	0.88
South import	23.26	40.36	0.8
North import	11.61	43.8	0.62

In summary, it can be seen that the optimization scheme is effective, the queue length, vehicle delay, and parking times have been basically improved, and the optimization measures are effective.

6 SUMMARIZED

This article chooses Renmin Road, Tanan Road crossing point as study target.Firstly, the traffic volume and other data are collected by field investigation, and then evaluated by analyzing the traffic capacity and saturated flow rate. Finally, the traffic organization is optimized.

Due to various factors, it is impossible to accurately obtain data such as saturated headway, and it needs to be measured more accurately in the future. The optimization scheme is only evaluated by VISSIM traffic simulation, which is not tested in practice.

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