The Traffic Organization and Optimization Case on Changchun City Intersection ——the Renmin Street and South Ring Road intersection

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Abstract： In this paper, it takes the Changchun Renmin Street and South Ring Road intersection for example to design the method of traffic organization optimization. On the basis of increasing the number of the channels of import and export, it changes the six phase control to the traditional four-phase control by Webster signal timing method. And the turn left non-motorized vehicles area is proposed. Finally, through the VISSIM simulation, it improves the status of urban traffic congestion and the urban traffic organization optimization process.

1 Introduction

With the rapid development of Chinese economy, the problem of traffic congestion has become increasingly prominent. In the case that the existing road network can not be changed, the delay can be reduced by optimizing the intersection [1]. This paper takes the Changchun Renmin street and South Ring Road intersection for example to optimize the design of the intersection according to the principle of optimization intersection traffic organization.

2 Traffic investigation and analysis

2.1 Intersection size and traffic flow parameters

Figure 1 illustrates the intersection plane，and the phase of the signal is shown in Figure 2.

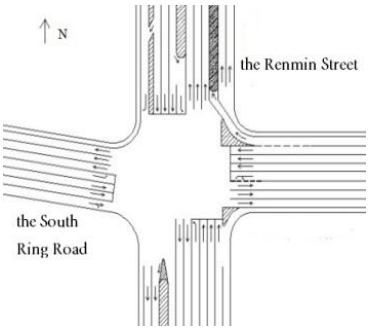

Fig.1Intersectionplan

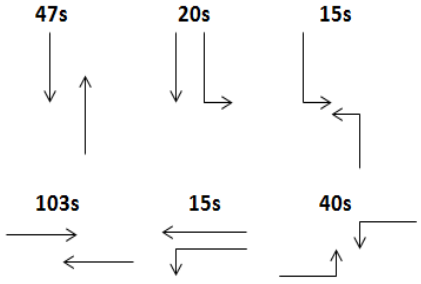

Fig.2 Signal phase

Table 1shows the data of early peak 7:30 - 8:30 period.

Table 1 the Survey of the intersection traffic

Import Road	Flow (pcu / h)			
	Through	Left-turn	Right-turn	Total
East	1442	412	587	2641
West	956	400	424	1780
South	1025	268	432	1725
North	1247	319	442	2108

2.2 Intersection characteristic analysis

Through the research and analysis, it is known that there are the following problems in the existing intersection:

(1) In the control mode of the signal, the six phase control method will increase the total delay of intersection [2];

(2) There is unbalanced flow distribution on the intersection during the peak period.

(3) In the release mode, there is traffic conflict between the left turn non motor vehicle flow and the straight vehicle flow.

3 Optimum design of intersection

3.1 Channel optimization

(1) Reasonable canal control can lead to the traffic flow in different directions, and it can reduce the traffic conflict of the intersection, and make the road traffic always orderly, efficient and safe [3]. So, it can be considered to increase the number of import and export lanes by compressing the lane width. Field investigation found that pedestrians and non-motorized traffic within the intersection is not great, so the 2m wide non-motorized vehicles import path can be changed for motorized vehicles, while reducing other straight lane to 3m width, which are shown in Figure 3.

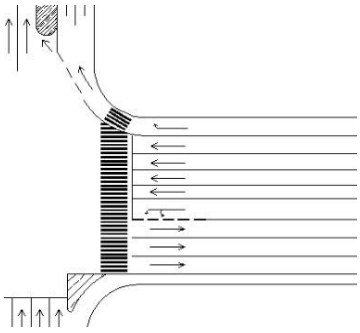

Fig.3 South Ring Road East imports canalization

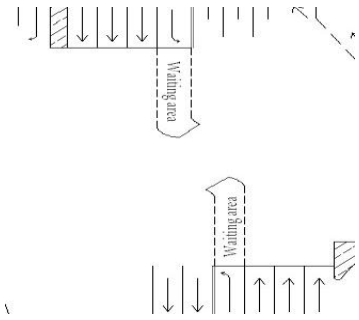

Fig.4 Left waiting area canalization

(2) The Renmin Street is the main road in Changchun City and the left turn traffic during the peak period is great. The left turn lane is too short in the original scheme, which is not enough to accommodate the number of left turn vehicles in the peak period, leading to overflow. Therefore this article is intended to set the left turn waiting area in the north entrance of the Renmin Street. When the left turn vehicles with straight driving into the left turn waiting area, making the rear left vehicle move forward a certain distance to make room for a straight line. The specific channel of the graph is shown in Figure 4.

3.2 Signal optimization

The lap six phase control method used in the original scheme would increase the total delay of the operation of the vehicle [4]. Therefore, this article takes minimizing the total delay as the goal, using

the traditional four-phase control mode to reduce the conflict between traffic, then optimizing the timing of the intersection with the Webster signal timing method.

Optimum cycle: $c_0 = \frac{1.5L+5}{1-Y}$ (1)

Total loss time: $L = \sum_{K}(L_S + I - A)_K$ (2)

The sum of the traffic flow rate of each intersection: $Y = \sum_{j=1}^{j} \max[y_1,...,y_j] = \sum_{j=1}^{j} \max[(\frac{q}{S}),....]$ (3)

Total effective green time: $G_e = C_0 - L$ (4)

The effective green time of each phase: $g_{ej} = G_e \frac{\max[y_1,...,y_j]}{Y}$ (5)

The green signal ratio of each phase: $\lambda_j = \frac{g_{ej}}{C_0}$ (6)

Display green time of each phase: $g_j = g_{ej} - A_j + l_j$ (7)

Four phase control method is shown in Table 2.

Table 2 Timing optimization & Green ratio

phase	g_j	λ	
E—W through	44	0.26	Note: Cycle time is 175s, the yellow light time is 3S,and there is 3s full red time after E—W straight line phase.
E—W turn left	42	0.24	
S—N straight	43	0.25	
S—N turn left	31	0.18	

According to the above calculated phase distribution, the cycle length is much smaller than the original program.The optimized scheme can reduce the waiting time of the vehicle at the intersection, thus reducing the delay, and regulating the operation order of the vehicle, then reducing the conflict between the traffic flow and improving the operation safety of the vehicle.

3.3 Release mode optimization

The Renmin Street is the main road and has a non-motor vehicle lanes, therefore, it will be separated by a non-obvious when the motor vehicle and motor vehicle reaches the intersection. It sets a "left turn non motor when driving area" at the South Ring Road outside the crosswalk to make the left turn non motor vehicles along with the straight line of motor vehicles enter the waiting area and through the intersection by two times to wait, while adjusting the signal timing accordingly. The increase of 3s all red time after the end of the E—W straight phase is for the stranded non-motorized vehicles within the intersection.

4 Simulation verification

Taking into account the simulation run time [5],it chooses the intersection capacity, the average queue length, maximum queue length and delay level of evaluation as the evaluating indicator, comparing the original program and the optimization on the output of the final evaluation index through the 3600s simulation.

(1) The comparison of the capacity of each direction is shown in Figure 7 (unit: veh /10min).

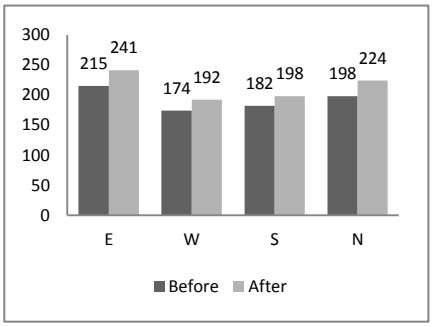

Fig.7 Capacity

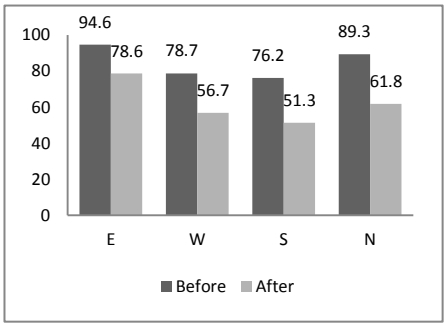

Fig.8 Delay Level

(2) The comparison of the delay of each direction is shown in Figure 8 (unit: s).

(3) The comparison of the average queue length and the maximum queue length are shown in Figure 9 and Figure 10 (unit: m).

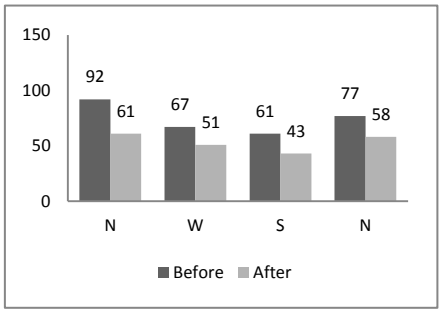

Fig.9 the average queue length

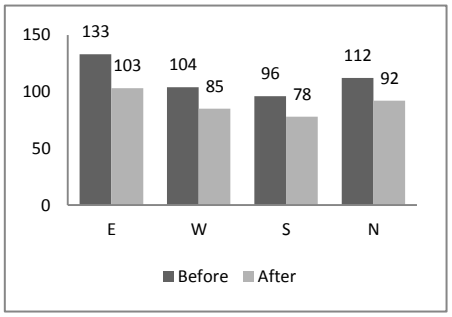

Fig.10 the maximum queue length

It can be seen from the simulation results that the capacity of the traffic in all directions are increased after optimization. The "non-motor vehicles waiting to turn left drive zone" greatly reduces the interference of non motorized vehicle on the straight line of the vehicle. And the line length is reduced, and the delay time of the intersection is significantly reduced.

5 Conclusion

In this paper, it studys on traffic organization optimization measures of Urban Plane Intersection. As the maximum traffic capacity and the minimum delay for the principle, it organizes and optimizes the intersection from three aspects of the canal design, signal control and release mode. Finally, the overall efficiency of the intersection will be improved, and good control effect will be achieved.

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