Study on the Application of One Way Traffic Organization for Narrow High Frequency Road Sections─Take Yutuo Road in Lhasa as an Example

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Abstract: *By analyzing the characteristics of single traffic and the current utilization of branch roads in urban road system, this paper takes narrow high-frequency road sections as the optimization object of single traffic organization and branch roads as the auxiliary optimization object to reduce road load. The TTI method is used to calculate the index when the road is congested, and the saturation of the road section is calculated. At the same time, considering the impact of intersection delay on one-way traffic and path selection, the traffic signal timing scheme at the intersection is calculated.*

Keywords: *One-way traffic organization; Saturation; TTI method; Congestion index; Traffic signal timing*

1. Introduction

The traffic congestion problem has begun to become one of the main problems to be solved in the process of urban traffic development in China. In order to solve some of the adverse effects caused by the increase of urban traffic volume, the government has set up a road that is in line with the requirements The implementation of one-way roads, one-way traffic can reduce accidents by 10-15%.

In the road system, several routes are organized to carry out one-way traffic and form a connected system, which is called road single-lane traffic [1]. The setting conditions of a single traffic mainly include the following six aspects: road network conditions, road section conditions, road section conditions, road width conditions, road intersection conditions and traffic flow conditions. This paper also considers the conditions of these aspects.

The purpose of unidirectional traffic organization method and its application research for narrow and high-frequency road sections is to select an optimal combination of traffic directions for the study section in a suitable range by changing the traffic capacity of the existing narrow and high-frequency road sections, so that the section can achieve a certain optimal performance.

Based on the above analysis, this paper calculates the index of road congestion, designs the signal timing scheme of the intersection to study the application organization of one-way traffic, and provides reference for the government to formulate relevant policies and implement the development of one-way traffic.

2. One-way traffic organization ideas

2.1 Road network adjustment

The one-way road structure in the region can be organized according to the following three forms in the structural form of road network planning[2].

(1) Pairing single row or one-way binary path adjustment schemes

For the regional road network, there are two parallel to the main route, but the internal branch and secondary lines are perfect. In the planning and design of one-way road in the region, the original parallel main road can be designed into a paired single row, the starting and ending points of the main road are consistent with the horizontal direction in principle, the maximum traffic flow of the internal branch and branch roads is the same, and the land use roads on both sides of the road can be paired single row or two-way driving, and the management of external nodes and internal nodes can be adjusted

synchronously. The traffic management method is suitable for strip layout and areas with parallel main roads , as shown in Figure 1 and Figure 2.
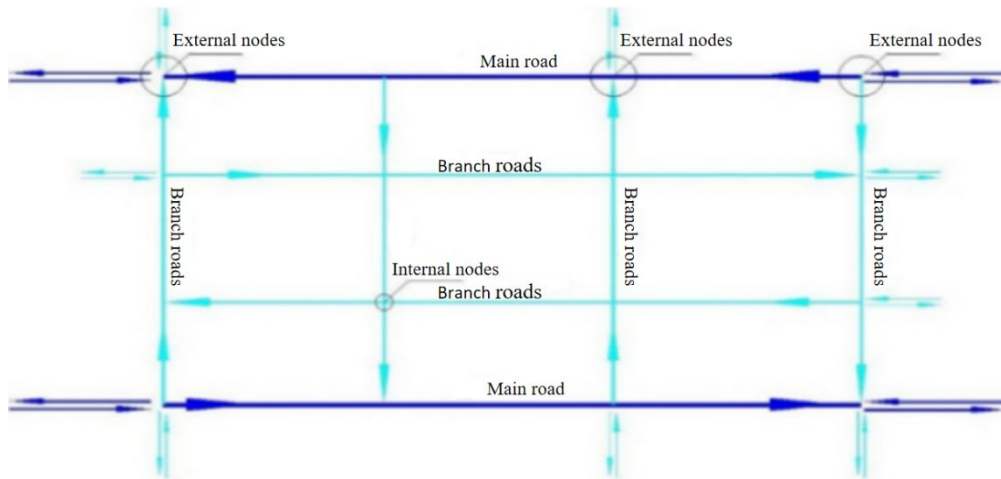

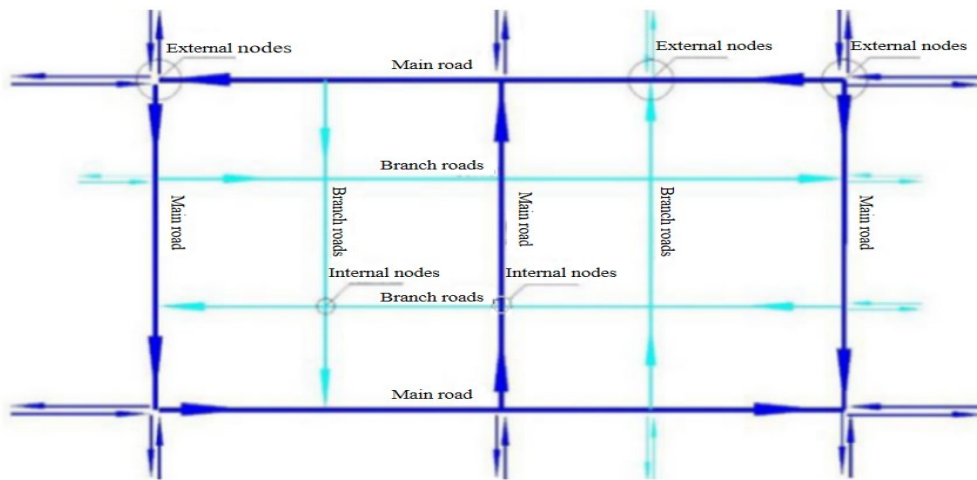*Figure 1: Schematic diagram of regional one-way traffic organization*

Figure 2: Schematic diagram of regional one-way traffic organization

(2) Grid road network (checkerboard road network) adjustment scheme

In view of the road network structure with square layout and parallel main roads in the regional road network, the choice of regional one-way transportation combination method can be through the circulation transportation combination direction of flow direction, the peripheral main roads are closed in principle, and the inner main roads, branches and branches are more flexible through one-way or two-way mode. The combined method is also suitable for areas with regular layout of urban road networks.

(3) Irregular road network adjustment scheme

According to the current situation of irregular road network in the area, one-way road traffic management measures in the district can be taken by making the enclose main road closed in principle, the access mode is organized according to the circulation of traffic direction, and the internal road is designed according to the node organization of specific analysis. This kind of traffic combination form is suitable for the urban road network irregular or the terrain fluctuation larger area , as shown in Figure 3.
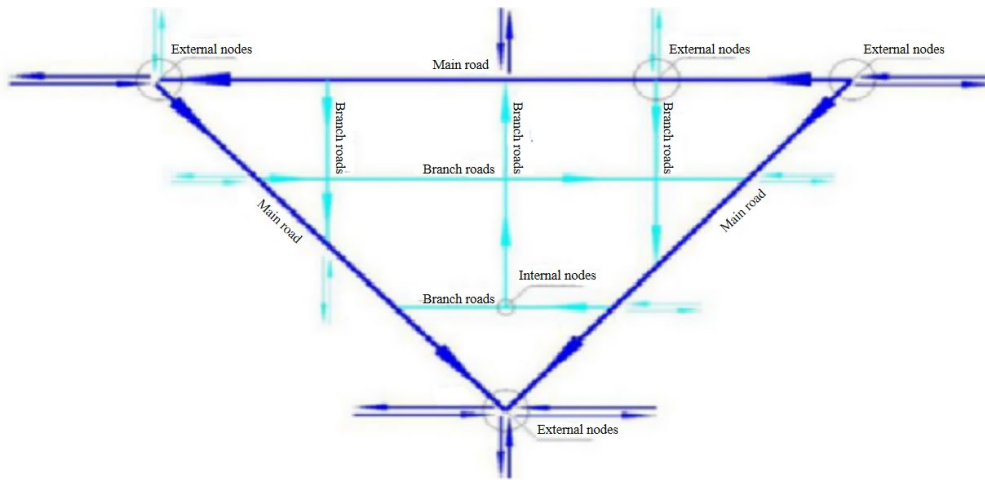
Figure 3: Schematic diagram of regional one-way traffic organization

3. Application analysis of one-way traffic organization

3.1 Analytical method

Considering that Yutuo Road is shorter (about 500 m) than the general road with one-way traffic at the time of implementation, this paper focuses on the adaptability analysis from the technical perspective [3, 4]. The implementation of one-way road on Yutuo Road alleviates the burden of Yutuo Road and nearby roads to a certain extent, especially the road burden near the intersection of Yutuo Road - Kangangdu Road south and Yutuo Road - Dosangge Road south. But at the same time, some vehicles also need to detour, which causes some interference to the surrounding urban roads. Through the study of interval traffic flow, the most disturbed important road nodes are evaluated, and the interference of the one-way channel of Yutuo Road to the interval traffic network is studied, and then the applicability of this measure is judged [5].

3.2 The TTI method calculates the index when the road is congested

In order to facilitate a more detailed discussion of the data, V is used here to represent the total road traffic volume, and traffic volume refers to the number of motor vehicles using the measurement point in a unit or at the same time. The road traffic volume can also be expressed as one minus one according to the equation. For a simpler discussion in the paper, the total traffic volume every five minutes is used to analyze the relevant values, and T=60m in this paper The in.

$$V_{5min} = \frac{N}{T} * 5 \tag{1}$$

In the formula: T- observation time, min;

Number of vehicles in an hour, veh

This paper will use TTI to measure the phenomenon of urban traffic jams. TTI means the ratio of the time spent on a certain road section that must be passed in peak hours to the time spent on the same road section in leisure hours. For example, a TTI of 1.3 means that it must take 20 minutes in leisure hours, while it must take 26 minutes to pass the same intersection in peak hours. The calculation formula is given in Equation 2 below.

$$TTI = \frac{T_P}{T_f} = \frac{S_f}{S_P} \tag{2}$$

In the formula: TTI- travel time index;

T_P- Peak travel time, min;

T_f- Idle time travel time, min;

S_P- Travel speed during rush hour. Km/h.

S_f- Idle time driving speed. Km/h.

3.2.1 The effect of different time periods on TTI

All cities in China have established road traffic operation indicators to measure road traffic operation. At present, there are two main measurement methods as follows: proportion of serious traffic congestion [6] and travel time index. We used the road travel time index TTI to describe the road traffic operation during that period in Figure 4.
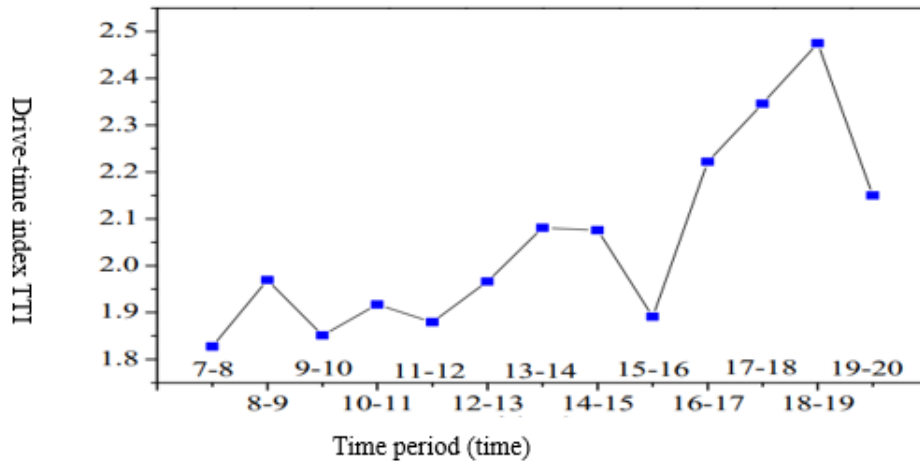

Figure 4: The effect of different time periods on TTI

3.3 Traffic assignment method using User Equilibrium (UE)

Let travelers independently choose their own path with the least travel time. The mathematical model is expressed as follows:

$$\min{}_{zUE}(X) = \sum_{a \in A} \int_0^{X_a} t_a(x)dx \qquad (3)$$

constraint condition: $\sum_{k \in K^\omega} f_k^\omega q^w, \forall \omega \in W$

$$X_a = \sum_\omega \sum_{k \in K^\omega} \delta_{ak}^\omega f_k^w$$

$$f_k^\omega \geq 0, \forall k \in K^\omega \omega \in W \qquad (4)$$

In the formula: 1) xa represents the traffic flow of road section on a;

2) f_k^ω represents the traffic on the KTH path of an OD pair ω ;

3) ta (x) is a function of the travel cost of the link.

4) q^ω represents the segment traffic volume on the OD point pair ω ;

5) δ_{ak}^ω is a continuous relation variable, if path k contains road segment a, $\delta_{ak=1}^\omega$, otherwise $\delta_{ak=0}^\omega$; K^ω denotes the set of paths on an OD pair ω , which may or may not have traffic;

6) A represents the set of all road segments in the traffic network;

7) W denotes the set of all OD pairs of the transportation network. $t_a(x)$ is generally expressed using the BPR function:

$$t_a(x) = t_0(1 + 0.15(\frac{x}{C_a})^4) \qquad (5)$$

In the formula: 1) t0 represents the free flow speed of section a;

2) Ca denotes the capacity of road segment a. The link cost function is convex and has second-order continuous reciprocal.

UE optimal condition:

$$f_k^\omega(c_k^\omega - u^\omega) = 0, \forall k, \omega \qquad (6)$$

$$(c_k^\omega - u^\omega) \geq 0, \forall k, \omega \qquad (7)$$

$$f_k^\omega \geq 0, \forall k, \omega \qquad (8)$$

Where path travel time:

$$c_k^\omega = \sum_a t_a(x_a) \delta_{ak}^\omega \qquad (9)$$

3.4 Implement joint control of signal lights

The width of road intersections on the whole line of Yutuo Road is small, especially the east and west end of the main line of Yutuo Road is only 500m, which has a great impact on road traffic. Joint control lights need to be installed to enhance the road traffic function[7].

4. Peroration

The implementation of one-way road traffic planning should not be static, but also need to carry out continuous research and evaluation according to the characteristics of regional road traffic, and make real-time fine-tuning of the organization plan to improve the overall quality of the local road network. This chapter will take Yutuo Road as an example, combined with the study of regional traffic flow, systematically analyze the influence of the one-way traffic organization system on the surrounding traffic network, especially on the main intersection in the traffic system, analyze its applicability to the formulation of the single-lane traffic organization system, and provide the optimization traffic combination method, which provides guidance for the establishment of the single-lane traffic organization system in Lhasa and other cities in China Important reference.

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