Research and Application of Microcirculation Theory in small cities

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Abstract. This paper introduces the traffic microcirculation theory, proposes the innovative traffic microcirculation system theory to control the urban traffic congestion concrete method, applies this method to the small urban traffic congestion area; Taking the Anyi bridge area in Anyi county as an example, this paper analyzes the current situation of traffic congestion in the area, proposes the recent traffic organization optimization plan by using the traffic microcirculation theory, manages the traffic congestion problem in the area of Anyi bridge in Anyi county, and makes a systematic evaluation of the traffic organization optimization plan. Anyi long-term urban development plan, using traffic microcirculation theory method, puts forward of the long-term traffic organization Anyi bridge area, analyzes the forward Anyi bridge area traffic organization, as the forward Anyi bridge area traffic microcirculation system theory method, the city of Anyi road network will be improved greatly.

1. Introduction

Urban traffic congestion has become an urgent problem in most cities. Some big cities, such as Beijing, Kunming and Changsha, make rational use of idle sub-trunk roads and branches to establish urban traffic microcirculation, which greatly alleviates the problem of traffic congestion on main roads. In recent years, the number of motor vehicles in small cities has been blowout-like growth, urban road traffic disorder, compared with large cities, small cities are more dense idle streets and alleys. Therefore, the application of traffic microcirculation theory in road traffic in small cities is more worthy of consideration.

In recent years, many scholars have studied traffic microcirculation. Chen Qun defined the impedance function of traffic microcirculation intersection to optimize traffic microcirculation[1]; Wang Qiuping used the dense street network to organize traffic microcirculation to meet the increasing traffic demand of historic blocks, and selected the Caoshi Street historic block of Kaifeng City as an example[2]. A bi-level optimization model of traffic microcirculation network design is established and solved by genetic algorithm[3]. A traffic microcirculation network model is established by Cheng Qun[4]. Zhou Jiang's commentary reviews the Chinese and English academic literature on traffic microcirculation and traffic planning, and discusses the theory of traffic microcirculation as a guide for branch network planning. The applicability and the guiding principles of branch network planning should be followed[5]; Yang Jie and others have promoted the research on the legalization process of urban traffic in China[6]; Duan Liren introduced the important role of
traffic microcirculation in improving urban traffic. Taking the local traffic organization of Anyi Bridge in Anyi County as an example, this paper studies the traffic microcirculation theory in the congested area of small cities [7].

2. Theory of traffic microcirculation system
"Microcirculation" is a medical term. If the whole city traffic is compared to human body, then the urban road is the blood vessel in human body. The whole road network is like the human vascular system, with aorta and vein, as well as capillaries, and the number and length of capillaries are much larger than those of aorta and vein. Urban expressways, trunk roads and sub-trunk roads are the main blood vessels and sub-blood vessels connecting each functional unit, and the branches, alleys and community roads outside the trunk road network are astonishing numbers of capillaries, which constitute the traffic microcirculation system[8]. Therefore, the traffic microcirculation system plays an important role in the whole urban traffic system. The role of dredging and coordinating.

The theoretical methods of traffic microcirculation system can be divided into the following four points:

- Choose the best traffic microcirculation road and divert the traffic volume of the main road;
- Reasonable organization of traffic, including: the choice of sections to set up one-way roads; intersections to set up prohibited left, prohibited straight, limited goods and so on;
- Setting up traffic diversion signs to guide traffic microcirculation vehicles to run in a standardized manner;
- Adding parking lots for motor vehicles and non-motor vehicles to avoid occupying traffic microcirculation roads and affecting the normal operation of traffic microcirculation.

3. Traffic problems in the area of Anyi Bridge
Anyi Bridge is the main road connecting the new and old urban areas of Anyi County, but as shown in Table 2 below, the peak traffic volume is only 1008 pcu/h and the saturation is only 0.72. The main cause of traffic congestion is not the excessive flow of motor vehicles, but the complex composition of traffic flow, the large number of motor vehicles (cars, trucks), non-motor vehicles, especially tricycles, which seriously interfere with each other, traffic jams are easily caused.

As shown in Tables 1 and 2, the road saturation around Anyi Bridge is not high, but the problem lies in the lack of road machinery, non-motorized sites, the disorderly parking of non-motorized vehicles, the occupation of road space, the decline of road capacity, seriously interfering with traffic order.

| Name of intersection                  | Current Traffic Volume (pcu/h) | traffic capacity (pcu/h) | saturation | service level |
|---------------------------------------|-------------------------------|--------------------------|------------|---------------|
| Dongmen Road-Jiefang Road and Wenfeng Road | 2953                          | 4000                     | 0.74       | D             |
| Dongmen Road and Anyi Bridge - Yanhe East Road and Yanhe West Road | 1998                          | 2800                     | 0.71       | D             |
| Anyi Bridge-Bridge South Road-Lianyu Road | 1472                          | 2300                     | 0.64       | C             |
| Jiefang Avenue Branch-Yanhexi Road    | 1057                          | 1800                     | 0.59       | C             |

There is a temporary transitional vegetable market around Beiqiaotou. The phenomenon of store-outlet operation and road-occupying operation of commercial stores on the street is serious, occupying road space, which makes the road capacity decline. Traffic volume in and out of the city during holidays has increased substantially, which makes the existing traffic supply unable to meet the traffic demand. In addition, the traffic order is chaotic, which is more likely to cause traffic congestion of Anyi Bridge.
Table 2. Peak hour service level of main roads around

| Road Name       | Current Traffic Volume (pcu/h) | traffic capacity (pcu/h) | saturation | service level |
|-----------------|--------------------------------|--------------------------|------------|---------------|
| Yanhedong Road  | 992                            | 1600                     | 0.62       | C             |
| Yanhexi Road    | 880                            | 1600                     | 0.55       | C             |
| Wenfeng Road    | 2400                           | 3200                     | 0.75       | D             |
| Jiefang Road    | 1100                           | 1450                     | 0.76       | D             |
| Dongmen Road    | 1600                           | 2000                     | 0.80       | D             |
| Anyi bridge     | 1008                           | 1400                     | 0.72       | D             |
| Qiaonan Road    | 1120                           | 1600                     | 0.70       | D             |
| Lianyv Road     | 1200                           | 1600                     | 0.75       | D             |
| Shengli Road    | 1116                           | 3600                     | 0.31       | B             |

4. Traffic organization optimization based on traffic microcirculation theory

4.1. Recent programme

The Anyi Bridge deck keeps two-way traffic unchanged; the north section of Anyi Bridge along Hedong Road-Dongmen Road intersection is equipped with isolation barriers, forbidding left-turn and direct traffic along Hedong Road and Hexi Road, reducing the conflict points at the North Bridge intersection and ensuring smooth traffic flow; the branch of Jiefang Avenue is equipped with one-way traffic from north to south. To form microcirculation with Jiefang Road and Hexi Road to solve the problem of left-turn vehicles leaving the city along Hedong Road; to construct interchange at the south bridge head of Anyi Bridge, the traffic pressure at the South Bridge Head intersection of Anyi Bridge can be shared by driving on the bridge or into Shengli Road from both sides of the bridge, and the left-turn and connection of vehicles are prohibited at the south bridge head of Anyi Bridge. Yulu Road prohibits left turn and avoids traffic conflict points at the south bridge head as far as possible, so that traffic volume at the South Bridge Head intersection can be evacuated quickly. During the time period (7:00-22:00), freight cars are restricted to enter the Anyi Bridge by tonnage, and cargo restriction signs are added to the main intersections on the north side of the Anyi Bridge.

![Figure 1. Organization chart of traffic optimization for recent schemes](image_url)
The Anyi Bridge runs in two directions to facilitate vehicles to enter and leave the old urban area. Setting up guardrails along the intersection of Hedong Road and Dongmen Road to avoid the conflicting points caused by the interweaving of left-turn and direct traffic flow along Hedong Road, left-turn and direct traffic flow along Hexi Road, and traffic flow of Dongmen Road directly running up and down Anyi Bridge. At the same time, the traffic order of the intersection and the Anyi Bridge is optimized. The traffic organization at the south end of Anyi Bridge and the construction of ramp between the south end of Anyi Bridge and Shengli Road can effectively relieve the traffic volume at the south end of Anyi Bridge and make it correspond to the traffic organization at the north end of the Bridge, so that the traffic organization at the north and South end of the Bridge can be optimized simultaneously and the bottleneck effect of the whole bridge traffic can be avoided. The corresponding generation. Different traffic organization schemes are adopted in different periods of traffic volume, which is flexible, improves road utilization rate, reduces many unnecessary traffic volume in the whole city, and has a positive effect on the traffic organization of the whole city.

4.2. Long-term plan
At the intersection of Renmin Road and Wenfeng Road, Renmin Road will be extended southward to intersect with the East Road along the river. A new bridge will be built at the intersection to connect Shengli Road, and the deck will be set to pass one-way from south to north. The Anyi Bridge is set as a one-way traffic from north to south, the extension section of Renmin Road is set as a one-way road from south to north, and the East Road along the river between the two bridges is set as a one-way road from east to west, thus forming the microcirculation of the road from Anyi Bridge to along Hedong Road to Xinqiao-Wenfeng Road. At the northern end of the Anyi Bridge, direct traffic along Hedong Road and left-turn traffic along Hexi Road are prohibited to reduce traffic conflicts at the bridge head. Set up signs and signs at the corresponding positions to guide the vehicles to drive correctly and pay attention to safety.

The Anyi Bridge and the newly built bridge form a cycle of entering and leaving the city, together with the traffic organization of the urban road between the two bridges, which greatly optimizes the traffic organization of the whole urban area; reduces many bypasses, avoids a large number of unnecessary traffic, and makes the traffic of the whole urban area simple, orderly and smooth. The distance between the newly built bridge and the Anyi Bridge is appropriate, which avoids the disadvantage of long detour distance. The traffic cycle between the Anyi Bridge and the newly built bridge reduces the traffic flow from south to north of the Anyi Bridge, standardizes the traffic order at the north and south ends of the Anyi Bridge, and effectively guarantees the smooth traffic of the Anyi Bridge and the nearby roads. Other traffic congestion points in the urban area will form a series of

Figure 2. Long-term traffic optimization organization chart
traffic linkage effects with the solution of traffic congestion problems at the North-South bridge head of Anyi Bridge and nearby roads, which will greatly alleviate the traffic problems of other roads in the urban area.

5. Conclusions
The definition of traffic microcirculation is introduced, and the theory of traffic microcirculation is innovatively summarized. A new idea of applying traffic microcirculation theory to traffic congestion areas in small cities is put forward to solve the serious traffic disorder problems faced by small cities. Taking Anyi Bridge area as an example, the causes of traffic congestion are analyzed and traffic microcirculation is applied. The short-term and long-term schemes are put forward and evaluated in theory, but there is no practical application data. The feasibility of applying traffic microcirculation theory in small urban areas needs to be verified by further simulation experiments with real traffic data.

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