Simulation of Traffic Microcirculation Optimization in Residential Area

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Abstract. Nowadays, there are many congestion problems in urban main roads, so the traffic flow on the main roads is drained to small branches, the density of road network is increased, a more perfect traffic network is formed, and many vehicle diversion paths are formed. Become one of the effective ways to alleviate traffic congestion. Through the optimization of traffic microcirculation network in residential area and the optimization of intersection signal timing scheme by Webster method, and the data analysis and simulation by using Aidaroe software and Vissim software, It can be concluded that the service level and network density of intersections around residential area are improved and the traffic condition is improved obviously. The results show that this optimization study has an important effect on improving the operation of traffic microcirculation in residential area and the quality of life of residents, realizing the efficiency of traffic microcirculation in residential area and affecting the whole urban traffic system.

1. Introduction

The organization and development of urban traffic is not only the way to increase the traffic of motor vehicles, but also the convenient life of residents, the orderly organization of street traffic, and the interactive connection of various systems in residential cities. On the research of traffic microcirculation at home and abroad, there are Christopher and so on (1995) [1] which think that the vehicle is introduced into the road with better capacity, and the suitable microcirculation system is established according to the road operation. The congestion problem of intersection can be effectively alleviated. Recent years, Song Xuehong (2008) [2] has systematically expounded the urban traffic microcirculation traffic construction planning theory and related application technology from five aspects: urban traffic microcirculation characteristics analysis, traffic demand prediction, traffic management planning, urban traffic microcirculation evaluation index system and engineering case analysis. Huang Enhou (2009) [3] discusses the key theoretical problems and optimization methods in the reconstruction and extension of urban traffic microcirculation system from the aspects of system function, network design, traffic organization and comprehensive evaluation, and provides scientific theoretical and methodological guidance for the reconstruction and extension of traffic microcirculation. Wang Haosu (2014) [4] pointed out that traffic microcirculation system should not only alleviate urban congestion and improve traffic...
efficiency, but also provide convenience for residents' travel, life and communication activities. Therefore, using the concept of traffic microcirculation, fully develop the potential of existing road network implementation resources, effectively organize and guide the traffic flow near residential areas, and reasonably control the growth of traffic demand. The construction of microcirculation urban traffic management system is of great significance to the stable development of urban economy.

2. Method Study

Through the use of residential microcirculation network optimization method, road traffic organization optimization method and Webster method to optimize the intersection signal timing scheme, the residential area traffic microcirculation network organization optimization design. Finally, the Aidaroe software and Vissim software are used to analyze and simulate the traffic situation.

2.1. Optimization of Microcirculation Network in Settlements

Traffic microcirculation roads are usually set up in the main and secondary main roads and their surrounding areas, and have enough low-grade shunt roads. At the same time, the choice of microcirculation road in the region must also have the traffic conditions and safety conditions to open traffic microcirculation. The relevant technical standards are shown in the table below.

| Influencing factor | Road conditions | technical standard |
|--------------------|-----------------|--------------------|
| Conditions of road facilities | Type of road, location of road in road network | Meet the requirements of defining urban functional areas |
| Road conditions | The road width should not be too narrow, and the difficulty of road reconstruction should not be too great | Road Red Line >3.5 m, Road Route Type and Section |
| Safeguard requirement | Generally avoid primary and secondary schools, hospitals and other areas of concentration of people | According to survey data and relevant specifications for safe passage |
| Traffic Equity | Can not encroach on other modes of transport travel rights, public transport priority | According to the local walking and non-motor vehicle traffic volume, road capacity and so on to determine |
| Historical Environmental Protection Requirements | Always adhere to the principle of giving priority to the protection of cultural monuments | It is the principle that the protective streets and alleys can not be removed and destroyed, and should be carried out according to the principle of small difficulty, convenient implementation and low cost |
| Intentional | Can not have a greater impact on the living habits of the original residents | Through the residents travel questionnaire survey to determine |

2.2. Optimal Design Method for Section Traffic Organization

2.2.1. Road cross section optimization design

Combined with the current situation of the road to carry out effective setting measures, generally speaking, when optimizing the road cross section, we should consider whether it is necessary to set up a central isolation zone, machine non-isolation zone, most road red lines do not support such, so
generally for setting isolation bar, more space saving. Or because of parking problems, you can compress the motor lane, non-motorized lane or sidewalk, and then roadside parking space.

2.2.2. Optimization of Road Traffic Organization
The traffic mode is combined. Dynamic traffic organization combination: residential area dynamic traffic planning management includes road system design, traffic streamline organization and other aspects. In planning management, attention should be paid to ensuring residents' travel safety, avoiding foreign vehicles, facilitating residents' travel and reducing environmental pollution. Static traffic organization: in the residential area, we should realize the combination of public transportation, parking facilities and slow traffic, so as to make the traffic environment of the residential area more healthy and convenient. Humanize walking traffic. In traffic organizations, slow traffic and public transport are given priority, especially for the disabled, children and the elderly; when people and cars coexist, the priority of slow-walkers is guaranteed, and cars are controlled, such as speed restrictions, passage areas, passage times, passage directions, etc. minibus policy control. Control the traffic volume of minibus, carry out traffic control in special time periods and lots to meet the needs of the pedestrian population by reducing the traffic volume of motor vehicles during the peak period; charge management, implement the policy of charging the parking system in the residential area, and share the urban parking facilities to realize the sharing of parking spaces and complementary parking peaks, reduce the pressure of road parking, and improve the quality of slow moving environment.

2.2.3. Optimization of Slow Traffic Organization
Delimit slow-moving areas. Commuting slow paths. Commuting slow path requires the road to be as straight and accessible as possible, identified and passed in the shortest time, and the motor vehicle network often has the above characteristics, so the commuting slow path can be set on the basis of the motor vehicle network. Leisure slow path. Combined with traffic flow, walking road width and other factors, leisure slow-moving road section can be classified into three categories, which are pure walking, slow-moving integration and non-paving. Humanized slow-moving facilities. Slow-moving facilities are the important elements to perfect the slow-moving space. Through the humanized slow-moving facilities, the slow-moving traffic environment is improved, and it is convenient for slow-walkers to pass, stay and traffic.

2.2.4. Parking Traffic Optimization Management
Based on the analysis of vehicle parking optimization, it is found that the parking space on both sides of the construction road in the research area is insufficient, the turnover rate is low, and there is the phenomenon of random parking.

2.3. Problem Intersection Signal Timing
Webster timing method: This method is based on Webster's estimation of vehicle delay at intersections, and determines a series of corresponding timing parameters by optimizing the cycle length. Webster's method, including related principles, steps and algorithms, is a classical method for calculating intersection signal timing. Webster model is a method to calculate signal timing aiming at minimizing vehicle delay time, so its core content is the calculation of vehicle delay and optimal cycle time.

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Its delay formula is obtained by calibrating random delay and average delay by Monte Carlo simulation method, such as the following formula:

\[ d = \frac{C(1 - \frac{q}{c})^2}{2(1 - \frac{q}{s})} + \frac{x^2}{2q(1 - x)} - 0.65\left(\frac{C}{q^2}\right)^{\frac{1}{3}} x^{2 + s\left(\frac{q}{c}\right)} \]  

(1)
In order to get the best cycle time to minimize the total delay of intersection, the best cycle time can be obtained by taking the partial derivative of the total delay to cycle time and making the partial derivative equal to 0.

\[ C_0 = \frac{1.5L + 5}{1 - Y} \]  

(2)

The model well reflects the quantitative relationship between vehicle delay and signal timing, traffic volume and saturation at intersections with low saturation.

The calculation formulas of basic timing parameters, such as green signal ratio, flow ratio, loss time and effective green light time of each phase, of various timing models are the same, only the cycle duration, and the calculation formulas of delay will be different due to different application ranges.

3. Example analysis
Taking Pingdingshan Jiatian Seine City as an example to optimize the traffic situation. Through the analysis of the present land use and road network layout, we know the corresponding problems existing in the traffic at present, so we plan to take three measures to reform the research area, the specific way is to open the guillotine road. Considering the comprehensive analysis of the present situation of the road, the key points of the optimization and the related indexes, the preliminary planning of the road network form is carried out for the optimization and improvement of the area around the city of Seine in Jiatian. As shown in figure 1, figure 2, draw the road network plan, then optimize the design according to the analysis and future planning layout, and get the feasible scheme of optimization.

![Figure 1](image1.png)

Optimization of Front Network Density Plan

![Figure 2](image2.png)

Optimizing the Density Plan of Backward Network
After the open design and optimization of the road network, the road network density in this area has increased a lot, making the road carrying capacity higher, sharing the traffic pressure of these main roads, such as construction road, Lingyun Road, Ping an Avenue, etc. It greatly facilitates the travel of residents of Jiatic Seine City and the road choice of other road drivers.

Analysis of traffic organization optimization design results: take Lingyun Road and Ping an Avenue as examples to optimize cross section, its road width is wide, two-way six-lane, because many nearby residential areas do not have parking garage, Make motor vehicles stop and place on the road. In the optimal design of motor vehicles, considering the design of parking in the road, the existing parking space is designed and reformed. On the urban road, parking can be set up by using the green belt gap. According to the investigation of the present situation of the construction road, the width of the green belt on both sides of the road is 8 m, so some of them can be used as parking space to save land resources, so the parking space is set up on the green belt.

![Motor vehicle parking space optimization chart](image)

Analysis of design results of construction road-Lingyun road:

| Import Road       | Turn round | Peak hour volume (pcu/h) | Design traffic volume (pcu/h) |
|-------------------|------------|--------------------------|------------------------------|
| East entrance     | Turn left  | 358                      | 454                          |
|                   | Craspedodrome | 1078                   | 1354                         |
|                   | Turn right | 43                       | 64                           |
| West entrance     | Turn left  | 278                      | 354                          |
|                   | Craspedodrome | 952                    | 1196                         |
|                   | Turn right | 334                      | 424                          |
| South entrance    | Turn left  | 243                      | 304                          |
|                   | Craspedodrome | 612                    | 765                          |
|                   | Turn right | 233                      | 292                          |
| North entrance    | Turn left  | 157                      | 201                          |
|                   | Craspedodrome | 650                    | 813                          |
|                   | Turn right | 271                      | 339                          |
According to the current signal timing and design signal timing as follows:

![Current Signal Timing for Import Road](image1)

**Figure 4 Current Signal Timing for Import Road**

![Port Road Design Signal Timing](image2)

**Figure 5 Port Road Design Signal Timing**

Through the use of Aidaroe software data analysis and Vissim software before and after the optimization simulation results are obtained:

| Evaluating indicator | Average queue length/m | Maximum queue length/m | Delay time /s | Saturation level | Service level |
|-----------------------|------------------------|------------------------|---------------|-----------------|--------------|
| Status programme      | 30.6                   | 46.6                   | 42.7          | 0.47            | D            |
| Prioritization scheme | 26.3                   | 37.5                   | 38.7          | 0.36            | C            |

As can be seen from the table above, Average queue length at intersections reduced by 4.3 m, A decrease of 14.0 per cent; m,9.1% reduction in maximum queue length A decrease of 19.0 per cent; 4.0 s, less delay A decrease of 9.3 per cent; Saturation drops by 0.11, The level of service has also changed from the original D to the C. level Ultimately through the use of Aidaroe software and VISSIM software for data analysis, Based on the output files, For comparative analysis, From the queue length, Delay, Saturation and service levels were compared, It can be seen that the optimal design scheme is superior to the current scheme from all aspects.

4. Conclusion and suggestion

In this paper, the traffic around the residential area of Jiatian Seine is taken as an example, through the traffic analysis of the research area, the traffic network microcirculation, the road traffic organization optimization and the intersection signal timing are optimized in detail. The result is that the optimal design scheme is superior to the current scheme in all aspects. Traffic microcirculation is not only related to the function layout, traffic organization, road network structure, but also to the management mode, urban economic and cultural background, and the overall traffic environment. In the future, the
study of traffic microcirculation in residential areas can be further improved from the aspects of constructing double-layer model of traffic microcirculation network optimization, traffic demand prediction and traffic microcirculation evaluation index system.

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