



Special Intersection Traffic Optimization Design

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Abstract In the urban road traffic system, intersections are the bottleneck of capacity and the high incidence of traffic accidents in the road network. With the increasing of traffic volume, the problem of irregular intersections of urban roads becomes more and more prominent. Taking the intersection of yingbin road and qimao street in qihe county as an example, this paper expounds the design scheme of traffic organization improvement at the intersection, and analyzes and evaluates the optimization design scheme with traffic simulation software and traffic evaluation software. The results show that the vehicle saturation and parking delay of the intersection are improved after the optimal design scheme is adopted, which verifies the effectiveness of the scheme and provides a design idea for the intersection.

Keywords urban road; special-shaped intersections; traffic simulation

1. Introduction

In the urban road traffic system, the intersection is not only the bottleneck of the road network's ability to pass, but also the area with high incidence of road traffic accidents. The optimal cross form of urban road is the four-way orthogonal intersection, which makes the crossing capacity to achieve the best, the shortest passage time, the highest efficiency and good line of sight, high safety. However, in the actual construction, due to the terrain, terrain, urban planning and some special social and historical reasons, in the design and construction of intersections can not be done at right angles, the country's major small and medium-sized cities are more or less there are some strange intersections, such as X-type, Y-type, misplaced or multiple intersections, therefore, how to solve the traffic problems of such intersections is the most important in urban traffic management.

2. Problems at the special intersection and the idea of rectification

2.1 Problems

There are two main traffic problems at the alien intersection: traffic disorder and traffic accidents. These two problems are common in road systems, but they are particularly prominent in view of the limitations of the geometric characteristics of the alien intersections themselves, mainly in the following three areas.

(1) Due to the influence of the geometric characteristics of the alien intersection itself, the right of passage of vehicles and pedestrians entering the intersection is not clear, the driving trajectory is irregular, traffic order is chaotic, and delays increase, resulting in low capacity.

(2) The import and exit of the intersection are not correct, which can easily lead to misjudgment of the driver's driving flow and cause traffic accidents.

(3) There is a sharp angle or multiple-way intersection in the flow of vehicles at intersections, which increases the collision point of traffic flow, and also has the problem of line of sight, which is prone to traffic accidents due to the driver's perception error.



2.2. Ideas for rectification

There are many kinds of rectification schemes according to the actual situation of the intersection, but the main rectification ideas are the following three kinds of treatment.

(1) The drainage design of the alien intersection should follow the general method of cross-channeling, adjust the location of the conflict point by channeling the design or change the nature of the conflict to meet the needs of the parties to the traffic flow. In the large area of the alien intersection canalization, it is possible to set the traffic island to standardize the driving limit of the vehicle, making it a normal standard intersection, thereby reducing the impact of the geometric line characteristics of the alien intersection on the vehicle driving.

(2) The optimization design of traffic organization at the alien intersection is difficult to implement, some misalignment or multiple intersections can appropriately limit the flow of one or several traffic flows in the multi-road intersection for traffic organization, the intersection range and the capacity of the traffic is not yet saturated multi-road complex intersection, through the intersection of the route can be rerouted, the transformation of the alien multi-junction intersection into a positive four intersection intersection, or the roundabout traffic organization.

(3) As a micro-traffic organization, the alien intersection traffic organization should coordinate with the macro-traffic organization in its area, and should not take the smooth flow of a single node as the goal of rectification, and should be the goal of improving the traffic capacity of the whole road network as the goal of intersection rectification.

3. Instance Analysis

3.1. Intersection status quo

3.1.1. Cross-channeling

Ying Bin road - Qi Mao road intersection for irregular four-way intersection, intersection by Ying Bin road and Qi Mao road intersection formed. The south side of the intersection is a two-way eight-lane road with 4 in and out, the north side of the intersection is a two-way 4 lanes, 3 in and 1 out, the north-east side of the intersection is a two-way eight-lane, 4-in-4 exit, and the west side of the intersection is a two-way 2 lanes, 1 in and out. As a key node in and out of the county town, the intersection carries more traffic flow, which is prone to congestion during peak periods, and because of irregular road intersections, there are large traffic safety hazards and traffic accidents.

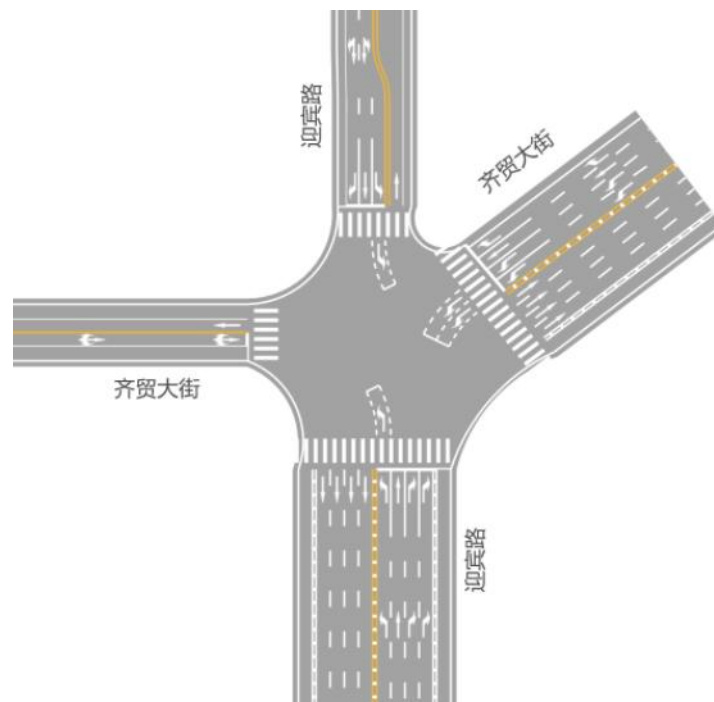


Figure 1: Ying Bin road -Qi Mao road intersection diagram



The intersection although the road cross-section in the four directions is a board, the cross-section is also different because the road width and lane division are not the same. Ying Bin road south of the intersection is shown in Figure 2, Ying Bin road north of the intersection is shown in Figure 3, East of the intersection is shown in Figure 4, and West of the intersection is shown in Figure 5.

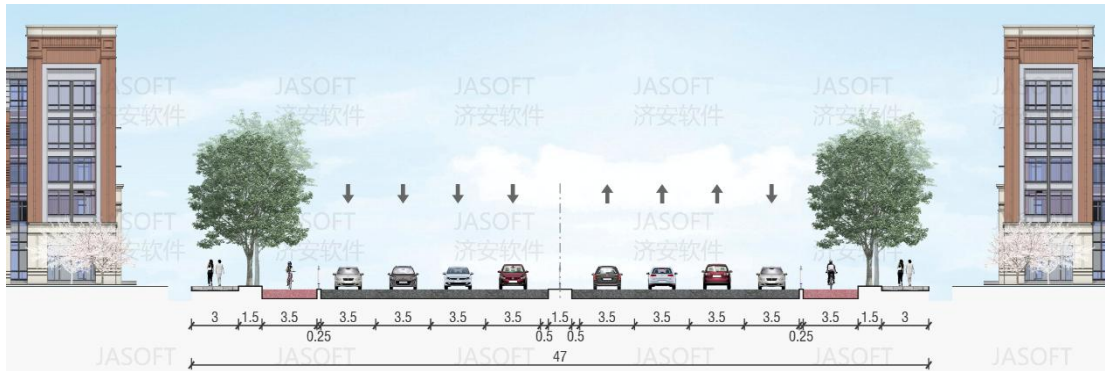


Figure 2: Cross-section of Ying Bin road south of the intersection

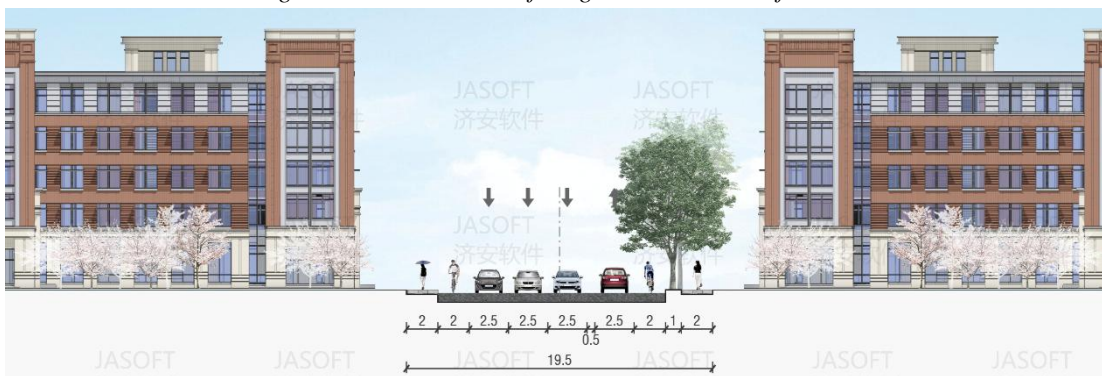


Figure 3: Cross-section of Ying Bin road north of the intersection

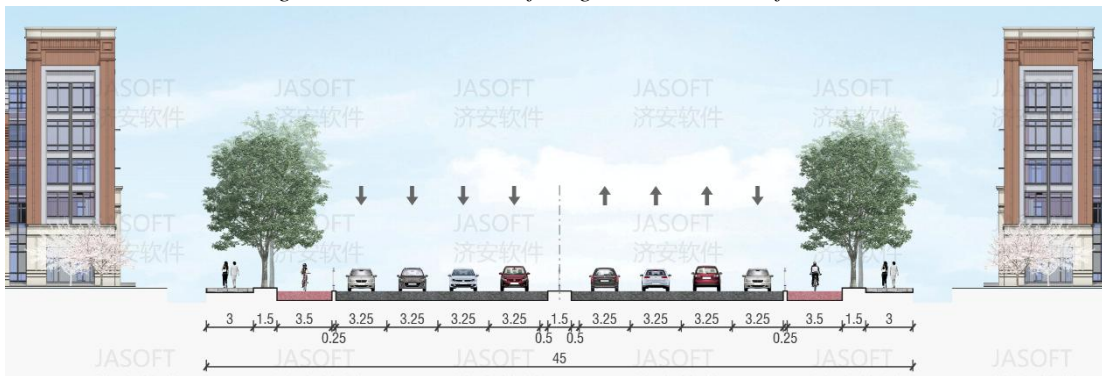


Figure 4: Cross-section of Qi Mao road east of the intersection

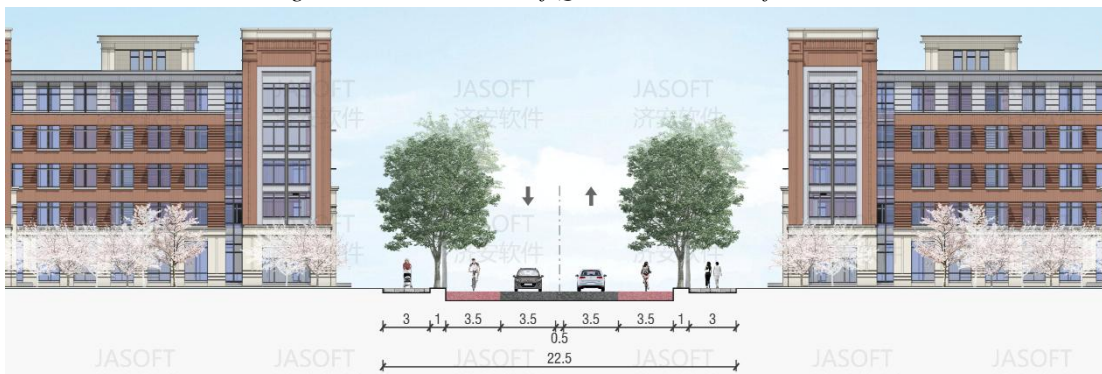


Figure 5: Cross-section of Qi Mao road west of the intersection

3.1.2. Intersection Traffic Survey and Analysis

Intersection Optimization Prior to the design, a traffic survey of the intersection status quo was conducted, as shown in Tables 1 and 6. It can be clear from the figure table that traffic volume is mainly concentrated in the south import right turn and east import left turn. At the same time, according to the flow distribution of different flows at the intersection also reflects the main distribution of vehicles in and out of the city.

Table 1: Traffic distribution at the intersection of Ying Bin road-Chi-Ting Ting Street

	North imports	Northeast imports	South imports	West imports
Left	305	859	482	296
Go straight	421	571	337	435
Turn right	306	356	1021	327

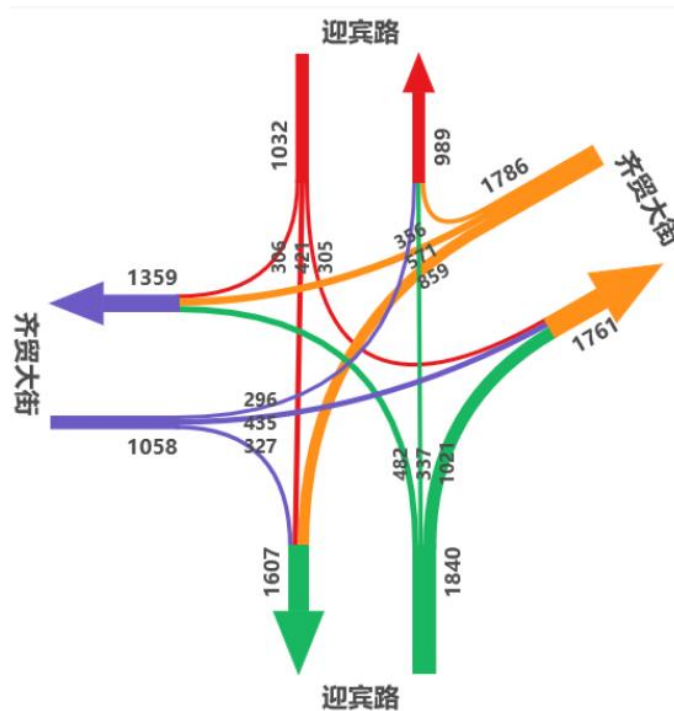


Figure 6: Traffic distribution map at the intersection of Ying Bin road-Chi-Ting-Ting Street

Ying Bin road - Qi Mao road intersection cycle length of 177s, the first phase is east-west straight, the length of 45s, the second phase is east-west left turn, the length of 36s, the third phase is north-south straight, the length of 50s, the fourth phase is north-south left turn, the duration of 34s.

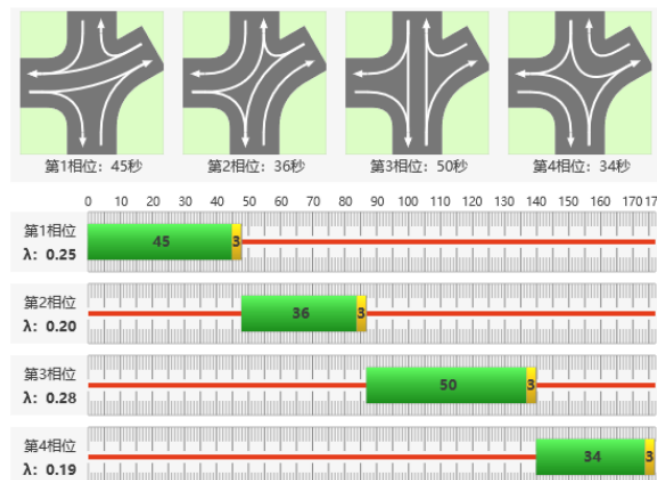


Figure 7: Ying Bin road - Qi Mao road intersection Status Signal Timing Figure

Delays, queue lengths and service levels at the intersection can be determined based on the flow and signal timing scheme at the Ying Bin road-Chi Trade Street intersection, as shown in Table 2.

Table 2: Ying Bin road - Qi Mao road intersection delay value and service level

Saturation	Average delay /s	Average queue length /m	Service level
0.45	42.2	53.51	and

Note: The level of service at road intersections is measured and assessed by delays, and according to the U.S. Road Capacity Manual, road service levels are divided into six grades, A to F.

3.1.3. The main problem at the status quo intersection

(1) The status quo intersection is an irregular four-way intersection, the corner between the north side of the intersection Ying Bin road and the northeast side of Qi Mao road is sharp angle, this form of turning traffic inconvenience, the driver is not easy to judge the direction, corner building difficult to deal with;

(2) The north and south sides of the intersection and the east and west sides of the road section form difference is large, traffic safety hazards are large;

(3) Traffic chaos at intersections, non-mixed phenomena of west and north import machines are serious, and the capacity of passage needs to be improved, making it difficult to adapt to future traffic needs

(4) The non-motor vehicle flow occupies a high proportion, the current situation intersection design is not considered enough;

(5) Crossing Northeast import pedestrian crossing is too long; no waiting area is set up, pedestrian to all parties to reach to improve.

3.2. Optimize the design of the scheme

3.2.1 Optimize Scenario 1

For the intersection of the shape, road identification fuzzy and other phenomena put forward an optimization scheme. Drain the traffic organization of the intersection, in addition to the left turn to the waiting area, to add the straight line to the area, so that the original traffic intersection is reduced, improve the traffic capacity of the road section. Because The West Import Is A Single Lane, The West Import Is Not Set Up In The Waiting Area. When using one-way one-way signal matching, that is, 4 imports 4 phases are released one by one, the release order is: South import (North import to be done) - North import (West import to be done) - West import (East import to be done) - East import.

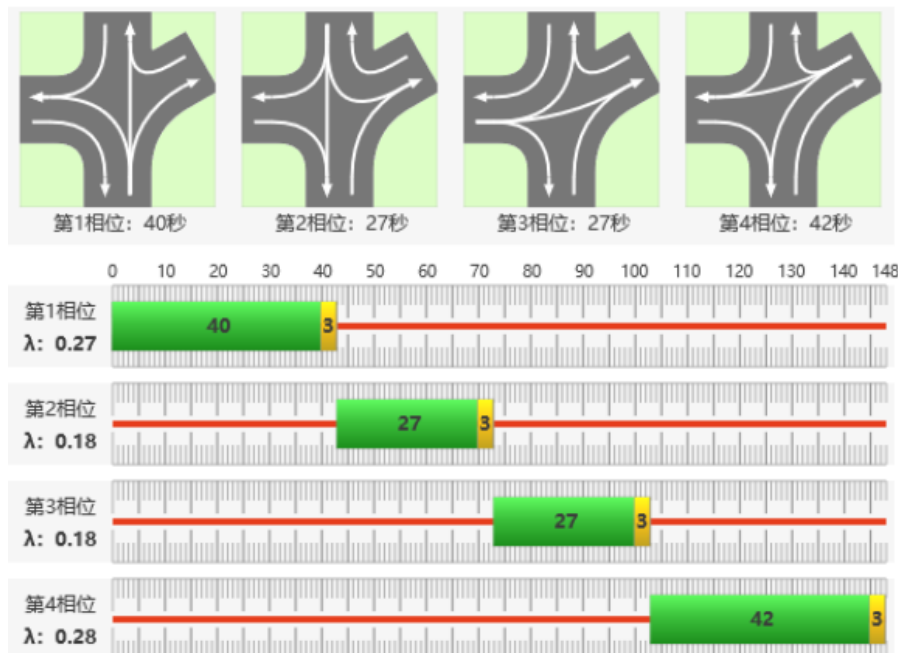


Figure 8: Ying Bin road - Qi Mao road intersection Optimization signal timing figure



(1) Set up a waiting area without affecting the passage, add 1 vehicle to the east to be in the waiting area, 1 vehicle to be directly to be driven by the northeast import, and 1 vehicle to be driven in the south, reduce the distance between intersections, shorten the vehicle travel time and improve the efficiency of traffic at intersections;

(2) Reasonable arrangement of traffic signs and markings to guide vehicles into the correct lanes and reduce the point of collision of the road;

(3) The original North Import 3 imports for 1 left turn 1 straight 1 right turn, now changed to 1 left turn 1 straight line 1 straight right, reduce the North import straight line delay, improve the straight direction of traffic efficiency;

(4) The signal timing is re-optimized, the four phases of one-way one-way are set, traffic safety and traffic capacity are improved, and the conflict points formed in the course of passage are reduced.

3.2.2. Optimization Scenario II

Ying Bin road - Qi Mao road intersection for the main node in and out of the city, the morning rush hour into the city more traffic, east import vehicles delay higher, and during the evening rush hour out of the city traffic volume is more, south import vehicles delay higher. In view of the morning and evening peak traffic congestion, tidal phenomenon prominent issues in the first plan on the basis of the optimization plan two. Set up reverse variable lanes in East Import, open reverse variable lanes during morning peaks, and improve the pass efficiency of east import left-turn vehicles. In the south import set the guide variable lane, during the evening peak period will be the straight lane to the straight right lane, improve the south import right-turn vehicle traffic efficiency.

3.3. Simulation evaluation

From the point of view of static traffic management, the difference of the complexity of intersection intersections before and after the transformation is analyzed by calculating the number of conflict points, diversion points and combined flow points of motor vehicle traffic flow lines before and after the transformation of intersections. There were 16 conflict points before the transformation of the Ying Bin road-Qi Mao road intersection, 8 diversion points and 8 convergence points. After the junction is canalized, there are 12 conflict points in Scenarios I and II, 4 shunt points and 8 convection points. Optimization schemes one and two effectively reduce the point of conflict, reduce the risk of traffic accidents, improve the traffic operation order.

From the intersection saturation, average delay, average queue length and service level 4 aspects, study the intersection before and after the transformation of the intersection traffic capacity differences.

Table 3: Crossroads Evaluation Indicator Comparison Chart

	Saturation	Average delay /s	Average queue length /m	Service level
status quo	0.45	42.2	53.51	and
Scheme 1	0.43	34.8	45.12	D
Scheme 2	0.42	33.1	42.64	D

As can be seen from Table 3, the two optimization schemes have improved in terms of saturation, average delay, average queue length and service level compared to the status quo scenario. Program I vehicle saturation has decreased compared with the current situation, but east import left turn and south import right turn pass pressure is greater, in the peak period prone to congestion. Programme II vehicle saturation is relatively small, the passage is relatively smooth, not easy to cause congestion.

In general, delays are used to measure the level of service at intersections. According to the service level standard provided by the U.S. Road Traffic Capacity Manual, The total traffic delay in Program I is 34.8s, which is a level of service level of D, as shown by unstable traffic flow, morning and evening peaks, more queued vehicles, lower speed and greater delays. Option 2 traffic delays of 33.1s, for the D-class service level, as shown by: traffic flow is more smooth, morning and evening peak, fewer vehicles in line, stable speed, less delay. In comparison, the vehicles in Programme II are more efficient to pass.



4. Conclusions

The rectification of the special intersection is of positive significance to improve the level of road traffic management, improve the operating environment of road traffic and optimize the traffic capacity of the city's overall road network.

(1) A comprehensive design analysis is carried out from the signal timing and traffic drainage in two directions, and a traffic organization optimization scheme is put forward. By re-optimizing its signal timing and drainage, the vehicle saturation, average delay, average queue length and service level are analyzed, and the conclusion of scheme TWO is the optimal scheme of the project.

(2) Encountering a similar special intersection can be not tied to fixed thinking, you can refer to the following ideas: set the waiting area, the use of one-way one-line timing scheme. However, the traffic flow of urban intersection models is more complex, still need specific intersection analysis, research and investigation.

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