Research on Optimized Strategy of Micro-Road Network in Jinan Ancient City

Hao Tong¹, Qiao Ning²*

¹ School of Civil Engineering, Shandong University, Jinan, Shandong, 250061, China
² School of Civil Engineering, Shandong University, Jinan, Shandong, 250061, China
*Corresponding author’s e-mail: lytonghao@163.com

Abstract: As the representative of ancient city in China, Jinan ancient city has obvious regional characteristics. However, in the process of Jinan’s development, a series of traffic problems such as traffic congestion and disorder have appeared in the ancient city. Taking the micro-road network of Jinan ancient city as an example, the paper analyses the current problems and reasons of road network structure, slow-traffic system, parking system, the public transport system and other aspects from its regional characteristics, and puts forward corresponding optimized strategies of micro-road network in Jinan ancient city.

1. The introduction
Urban micro-road network refers to the road network in the block with clear urban functions divided by the urban main road at the city scale, and the road composition in the block is simple. The micro-road network makes the urban road network planning more detailed, so that different planning modes can be adopted according to the different nature of land use and regional functions. Urban road planning takes urban micro-road network as the research object and adopts the planning mode of combining points and surfaces. This planning mode makes the urban road network diversified and flexible, and improves the traffic efficiency of the city.

With the acceleration of urbanization process, and the change of residents' lifestyle, travel demand and modes, the urban traffic situation is deteriorating day by day. From the perspective of national cities, the road framework network of most cities has been planned. The functions, spatial structure and natural environment of different urban areas are different, and urban integrated road network faces different traffic problems in different regions. For the solution of urban road traffic problems, the urban road network should be refined, and corresponding countermeasures should be put forward according to the regional characteristics. As a presentative of ancient cities in China, the ancient city of Jinan, which is at the core area of Jinan, has its unique characteristics in urban planning. The ancient city is also a concentrated area of urban road network problems in Jinan. Therefore, this paper analyses the problems of micro-road network in the ancient city and puts forward solutions.
2. Current Situation of Road Network in Jinan Ancient City

The ancient city was developed on the former site of Jinan city in Ming and Qing dynasties, and the overall pattern continued its old planning and layout. The main and secondary trunk roads formed a grid road network framework, which is compatible with the moat loop line. The ancient city has formed a road network structure of "three longitudinal roads and four horizontal roads". "three longitudinal roads" from west to east are respectively Baotu Spring North Road, Xianxi Street and Black Tiger Spring North Road, and "four horizontal roads" from north to south are respectively Ming Lake North Road, Daming Lake Road, Spring City Road and Black Tiger Spring West Road. "four horizontal roads" are the main roads of motor vehicles in this area.

The study makes a statistic on the roads for motor vehicles. The total length of roads is about 20.18 km, of which the main road is 3.1 km, the secondary road is 7.64 km, the branch is 2 km and the secondary branch is 7.44 km. The road structure ratio is 1:2.46:0.65:2.4, and the road density is about 6.73km/km². In addition, there are a large number of uncounted pedestrian streets with a width of less than 6 meters, which cannot meet the needs of motor vehicles.

The slow traffic flow in the ancient city was mainly concentrated on the Furong street to Baihuazhou historical and cultural block. The block is full of walking streets and lanes, with compact space scale, which maintains the traditional landscapes such as traditional houses, bridges and flowing water. The quiet and comfortable traditional living environment is in sharp contrast with the noisy outside world. It is suitable for walking and playing, and provides a high-quality slow-moving environment. The road network of the historical and cultural block is mainly composed of urban living roads, with many short-distance traffic and few main traffic roads. The complete network of streets and lanes connects Spring City Road and Daming Lake Road. Meanwhile, the distance of 800 meters from north to south is within the acceptable range of pedestrians. Therefore, streets and lanes play a very effective role in reducing the conflict between people and traffic flow.
3. Problems in the Micro-road Network of Ancient City

3.1. The road network layout is unreasonable, the road proportion is unbalanced
In the ancient city, there are many small street branches and unreasonable use of roads, which makes the road density of motor vehicles low, and it is difficult to accommodate a large number of motor vehicles. According to the reasonable ratio of urban roads - trunk road: secondary road: branch road = 1:1.5:3, and secondary branches do not have the complete function of branches. The proportion of roads in the ancient city is unbalanced, and the proportion of branch roads is difficult to meet the demand, which leads to a large number of traffic flow concentrated in the main roads. Meanwhile, due to the uneven distribution of roads in the ancient city, the distribution of traffic flow in the ancient city is seriously uneven.

3.2. The slow-traffic system lacks transport facilities, and it is incoherent with public transport
Residents in the ancient city choose slow traffic in a large proportion, but the relevant traffic facilities cannot meet the actual needs. The main problems are as follows:

- The construction of bicycle lanes is perfect, but the width of some bicycle lanes is narrow. Most roads only rely on marking and surface colour to divide non-motorized lanes and there is a certain degree of mutual interference between non-motor and motor vehicles.
- Both sides of the road can basically ensure spacious walking space, but a large number of non-motor vehicle roadside parking occupies walking space.
- The ancient city lacks auxiliary crossing facilities. The plane crossing of people and traffic increases the unsafe factors of the walking environment and hinders the flow of motor traffic.

According to the field survey data, there are 28 bus stations and 41 bus lines in the ancient city. The density of bus stations is high, the bus lane layout is perfect, and the bus is more smooth than private cars. Due to the restrictions of the historical and cultural blocks in the central region, the distribution of bus routes is uneven, mainly concentrated on the east-west trunk road. Meanwhile, due to the lack of Shared bicycle parking points in some stations, slow-traffic and bus connections are incoherent, resulting in reduced travel efficiency.
3.3. Complex traffic conditions lead to many conflict points and low efficiency of intersections
T-shaped intersections are numerous and lack of effective control, and there are more car-car conflicts and pedestrian-car conflicts in the area. The intersections in the region have fewer signal phases, chaotic order and low traffic efficiency. In order to solve this situation, the Black Tiger Spring West Road and Spring City Road are set as one-way roads, and the longitudinal single-lane road between the two roads forms the micro-circulation inside the road network, which reduces the conflict points and alleviates the congestion of roads and intersections to some extent.

3.4. Parking Spaces are difficult to meet demand and dynamic traffic is disrupted
Lack of parking space is a common problem in ancient city. In 2017, the measures of prohibiting roadside parking in ancient city increased the space of road traffic, but further aggravated the difficulty of parking. The old city can only rely on the parking lots built in large commercial squares. Parking problems that are difficult to solve thoroughly make waiting vehicles stay in the road and increase the traffic burden.

4. Optimized strategies of micro-road network in Jinan ancient city
4.1. Optimize the structure and layout of the road network in the ancient city
In view of the imbalance of the proportion of branch roads, the lane space that can be widened and not used well could be reformed. In addition, improving the proportion of branch road network, ensuring the uniform layout of all levels of roads in the ancient city area and increasing the density of road network within the area are also effective measures, which could reduce the size of street width and improve the flexibility of travel within the area.

4.2. The Traffic Model of "Slow-Traffic + Public Transport"
The ancient city should advocate the "Slow-Traffic + Public Transport" mode, and encourage slow-traffic as the main way and public transport as the auxiliary way. Public transport, bicycle and walking are distributed from outside to inside and from far to near in the ancient city. Three ways intersect and connect with each other. According to personal travel needs, travellers can flexibly choose the combination of travel mode.

Public transport is mainly responsible for the external communication of the region. The ancient city needs to optimize the bus lines and reduce the repetition rate of the lines within the region. The bus station area is marginalized to reduce the impact of bus stops, and bicycles are used to increase the service radius of bus stops.

Bicycle is an important connection between walking and public transportation. Bicycle parking...
points are arranged at bus stations and the entrances and exits of crowded areas to meet travel needs. Walking space needs to reduce the squeeze from non-motor vehicles. Increasing street crossing facilities, such as flyovers or underpasses, can ensure the continuity of slow-traffic in the ancient city and reduce crossings with road traffic.

4.3. Improve the traffic efficiency of key nodes
To optimize the key intersections, if necessary, the turning radius of intersections can be increased to improve the efficiency of intersections. Due to the difference between the width of the road in the old city and the width of the external connecting roads, the intersections in and out of the old city are prone to form a traffic bottleneck. the phase of signal lights can be appropriately increased to make the intersections more orderly.

4.4. Improvement of parking system in ancient city
In view of the parking problem in the ancient city, while maintaining the scale of parking lots, we should rely on large-scale social parking lots around the area, and reduce the traffic flow in and out of the area through other modes of transportation. While reducing fixed parking Spaces in the road, temporary harbour parking Spaces can be provided. The stop-and-go parking mode shortens the connection time between vehicle and walk, reduces travel time and distance, and improves travel experience.

4.5. Separate transit traffic and protect internal traffic order
As a regional ring, the moat loop has little diversion effect due to the limitation of road width. We need to lay out the outer ring road in the periphery, such as Luoyuan Street as the main diversion Road on the South side. At key intersections, signs and other traffic facilities will be used to guide and divert transit and inbound traffic. The outer ring road can effectively reduce the transit traffic and protect the relatively fragile traffic order in the ancient city.

5. Summary
The ancient city records the history of the city and is also the source power of the development of urban characteristics. The effective solution to the problem of micro-road network in ancient city has greatly improved the urban development and image. This paper makes a detailed and in-depth analysis of the micro-road network in ancient city, adheres to the principle of improvement based on protection, puts forward the reasonable solution for specific problems. These measures effectively improve the insufficiency of micro-road network in ancient city, alleviate traffic pressure, create a safe and comfortable travel environment for the ancient city, and dredge key nodes for Jinan urban road network.

References
[1] Zhang, C. (2017) Study on traffic improvement strategies in historic areas-Take Jiuquan ancient city as an example. Urban Transport of China. 10: 55-57.
[2] Yang, J. (2018) Optimizing strategy of road network in Liwan historic old city of Guangzhou. Traffic and Transportation. 5: 63-65.
[3] Peng, M., Gai, C.Y. (2019) Study on road upgrading planning in Beijing old city renewal. Urban Transport of China. 17: 49-53, 101.
[4] Lu, C.L. (2012) Study on the development planning of slow traffic in Jinan urban core area. Shandong, Jinan.
[5] Ma, K. (2009) Discussion on the evolution and new pattern of urban streets. Tianjin university, Tianjin.