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Summary of Related Issues of Cluster Urban Roads -- Taking Chongqing As an Example

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Abstract

In recent years, with the continuous inflow of population into the city, the demand for urban traffic is growing, which has brought a series of urban diseases in traffic. In order to solve this problem, we must conduct in-depth research on the urban road network system. Taking Chongqing as an example, this paper first describes the distribution characteristics of cluster cities and the main embodiment of free-form road network in the main urban area of Chongqing, then makes a brief analysis of the problems brought by cluster road network, and finally puts forward some solutions or in-depth discussion on some key problems.

Keywords

Group city; Free road network; Traffic congestion; Industrial cluster.

1. BASIC CHARACTERISTICS OF CLUSTER URBAN ROAD NETWORK

1.1. Distribution characteristics of cluster cities

Transportation serves cities, and the distribution of cities will reflect the corresponding road network structure. Therefore, before studying the road network structure, it is necessary to analyze the characteristics of cluster cities. The so-called cluster is a form of settlement layout close to the cluster. Due to the influence of natural factors (such as land use, river barrier, etc.) or under the influence of human factors (mainly planning and control), the built-up areas are separated by rivers, farmland or green space, forming a number of independent urban regional forms, which are called cluster cities. The organic evacuation and open regional form of cluster layout is an effective mode to change the development mode of some big cities in China. In order to realize the sustainable development of the city and solve the traffic problems in big cities. Chongqing, Shanghai, Guangzhou, Dalian and other cities in China have the shadow of cluster cities.

The types of cluster cities are mainly divided into the following categories[1]:

Multi center cluster layout city: The development of various urban clusters is relatively balanced, with relatively complete functions within each cluster. Each cluster is relatively independent and forms its own system. All clusters are connected together by urban trunk roads, forming a multi center network city layout structure.

2. Marginal cluster urban layout: This type of cluster urban layout refers to the construction of a new urban area that complements the functions of the old urban area at the edge of the original city after the old urban area has reached a certain stage of development, with the old urban area driving the common development of the new urban area.

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3 Mixed cluster layout city: The mixed cluster layout integrates the characteristics of multi-center cluster layout and edge cluster layout, which is a combination of the two. The cities with this layout mode have multiple central clusters, and new urban areas have been built at the edge of some clusters, forming a mixed cluster urban layout. The mixed cluster layout has the characteristics of both the multi-center cluster layout and the edge cluster layout. The mixed cluster layout mode is the mode adopted by the large cities with multi-center cluster layout formed by geographical factors such as rivers and mountains in the early stage when they develop and expand in the later stage.

1.2. Characteristics of the road network in the main urban area of Chongqing

As mentioned earlier, due to the unique topography and landform of Chongqing, the main urban area is naturally divided into several clusters by mountains and rivers. It is a typical "multi-center and cluster" city in China[2]. The cluster layout formed by the natural division of its unique landscape is more representative. The development of urban space in Chongqing starts from the east end of Yuzhong Peninsula, develops to the west to the whole Yuzhong Peninsula, and then develops across the river. It starts from the east to the west according to the cluster layout, and then expands to the north and south under the restriction of mountains. With the further expansion of the urban spatial pattern, the city has developed across the Zhongliang Mountain and Tongluo Mountain to the east and west troughs, with the focus on the north.

The form of urban road network in clusters is mostly free, taking the trunk road connecting the centers of each cluster as the skeleton, forming a multi-center and radial pattern. Take Yuzhong Peninsula in the old urban area as an example, its road network structure is a free road network along the river, while some areas in the main urban area will also be blocked by mountains, and the direction of the road will be restricted by the terrain conditions, which makes it difficult to form a more regular road network. Therefore, most of the road network construction takes full advantage of the natural terrain to build with the terrain, forming an irregular free road network. In order to reduce the longitudinal slope, urban road alignment is usually arranged along the piedmont or river bank in combination with the terrain, or the length of the road is extended to overcome the natural elevation difference. The road curve does not have a certain geometry, resulting in fewer horizontal links, more broken roads, lower connectivity of the road network, and fewer alternative channels in the road network system. For some of these clusters, the main ways to connect them are bridges across two rivers and tunnels through mountains.

2. PROBLEMS ARISING FROM THE COMBINATION OF CLUSTER CITIES AND EXISTING FREE ROAD NETWORK

2.1. Urban traffic congestion

As mentioned earlier, due to the special geographical environment of Chongqing, it is not easy to form intersections in some areas, while merging multiple intersections in other areas with suitable terrain, resulting in uneven distribution of road network density, resulting in vehicles concentrated at a certain intersection, causing local congestion. Secondly, due to the lack of road evacuation capacity in these transfer areas, vehicles in this area cannot be evacuated, and the mismatch between the road diversion and the carrying capacity at both ends of the bridge and tunnel has caused a burden on the urban traffic management system.

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Figure 1. Local congestion of urban vehicles

2.2. The road network is not connected, resulting in a long detour time

People are usually willing to arrive at the destination in the shortest time and at the lowest transportation cost. In a single cluster, this may not be a problem, but for the cluster cities formed due to the division of terrain factors, river-crossing bridges and mountain tunnels are the main channels connecting the clusters, and the number of channels connecting the clusters is generally small. So we can only indirectly detour to the destination. Obviously, this runs counter to people's wishes.

2.3. Commuting between two places

The main traffic volume of the morning and evening peak in the city is contributed by the employees who commute between the work unit and the residential area. Due to the distance between the industrial cluster where the work unit is located and the residence of some employees, it is often impossible to avoid cross-cluster traffic. At the same time, because the road network structure of Chongqing is mainly free road network, the density of cross-cluster road network is low, which is easy to generate local congestion, thus prolonging the meaningless waiting time. For every person on the way home, this is really a pain in their heart.

2.4. Incomplete expressway construction

In order to alleviate the burden of the main urban area, reasonable construction of expressways can achieve the role of "traffic guidance" and let people move from the urban center to other clusters. However, at present, the development of expressways within Chongqing's two mountains is relatively good, with a relatively dense road network. However, they are mainly transformed from the main urban roads, which cannot fully exploit the advantages of expressways, and also hinder the guided development of the cluster. The density of the expressway in the cluster beyond the two mountains is too low to fully connect with other clusters, which limits the expansion speed of the cluster.

3. SOLUTIONS TO RELEVANT PROBLEMS

How can we improve the current unreasonable planning and alleviate the traffic pressure of the current road network? These are the questions we need to think about. Now I will make some suggestions on these questions.

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3.1. Fine management of traffic

According to the survey data provided by An Meng et al. at the 2018 China Urban Transport Planning Annual Meeting, the excessive traffic arrival rate of the road section leads to the "backlog" of traffic flow at the traffic nodes. This phenomenon occurs not only in the morning and evening peak, but even in the peak hours. As long as the "excess" of the traffic flow of the road section reaches, it can cause congestion at the nodes,it is just that the length or state of congestion is not as serious as the morning and evening peak, so the congestion at nodes is almost normalized. For example, the node of the ring road at two intersections in Yuzhong District of Chongqing is located at a high elevation of the terrain in Yuzhong District, which is not connected to the riverside system on both sides smoothly, and the connectivity of the connecting road is poor. According to the statistics of the road traffic operation detection platform in the main urban area of Chongqing, the average congestion index of the two intersection nodes at 7:00-20:00 in September 2016 was above 6, and there was no traffic congestion only at night. Due to the lack of horizontal connecting roads and the lack of traffic flow balance control, the traffic operation speed of the road section is generally high. For example, the Yangtze River First Road, which is connected by two intersection loops, has no road connection or traffic light control for up to 2 kilometers before reaching the intersection node. According to the platform statistics, the running speed of this section in September 2016 can almost reach more than 40km/h[3].

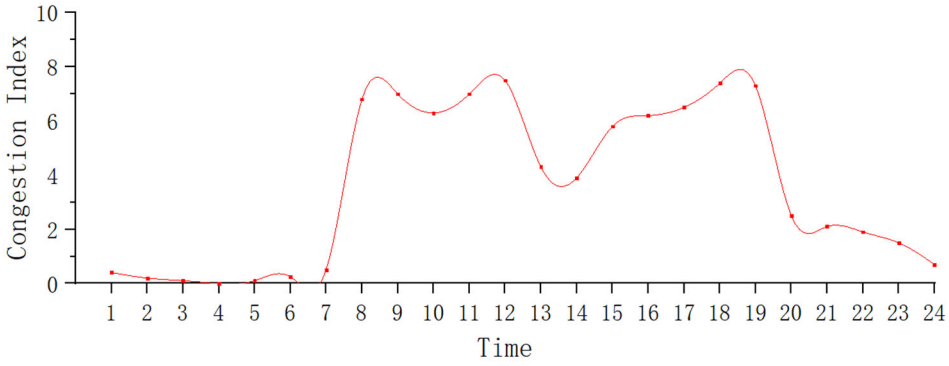

Figure 2. Daily and monthly variation of congestion index at lianglukou

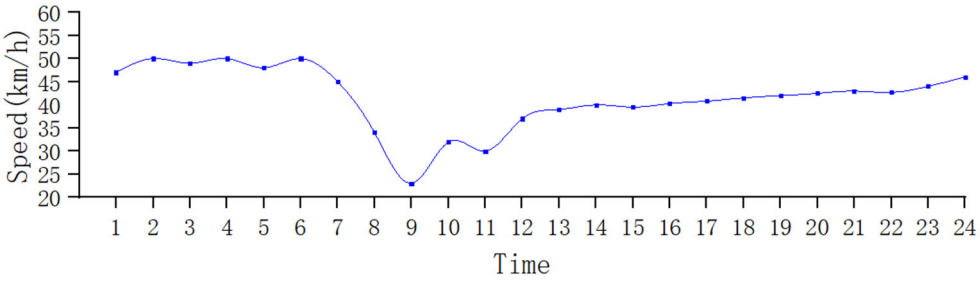

Figure 3. Daily and monthly variation chart of running speed of Changjiang No.1 Road

In order to solve these problems, traffic management can be refined. For long and straight sections without congestion, traffic lights can be set appropriately, or interval speed can be set to avoid excessive concentration of vehicles in the bottleneck section ahead of the peak. Traffic lights or traffic police shall be used for traffic control at the bottleneck section to avoid vehicles' forced congestion, lane grabbing and other behaviors that disrupt traffic order. For the intersection of vehicles, vehicles can be prevented from blocking at the intersection by restricting vehicle weaving. You can also control the time and space permissions of traffic flow

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in different directions to enter the weaving area by setting traffic lights in the weaving section, sort out the traffic flow lines in different directions, and reduce the conflict between weaving traffic flows. Lane separation can also be used to control vehicles coming from different channels to enter the weaving area, maintain the integrity of the traffic flow line of the channel, and reduce the secondary lane change of the weaving traffic flow. In terms of excavating road traffic capacity, tidal lanes can be set to limit directional lanes for lane changes, or soft isolation measures can be adopted for the remaining parts of the loop, forming reverse lanes during peak hours, avoiding the need for traffic flow to be converted through the loop, reducing the detour distance of small vehicles, and alleviating traffic congestion.

3.2. Vigorously develop rail transit and improve traffic

Due to the shortcomings of the free style road network in cross group transportation, and the excessive traffic pressure in the central area of the group, it is difficult to solve the urban transportation travel demand solely relying on ground transportation. Therefore, it is necessary to vigorously develop mass transit and give play to the backbone position of rail transit in long-distance and cross group transportation travel. Compared with plain pancake cities, cluster cities have obvious passenger flow corridors, which mainly appear in the traffic passenger flow corridors between clusters[4]. The closer the connection between the clusters, the stronger the dependence on the central urban area, the greater the communication demand, the more obvious the passenger flow corridor, and the obvious morning and evening peak tidal characteristics. From the analysis of the current situation, the current passenger flow corridors are generally concentrated on the highways, national highways and provincial highways with good road conditions connecting the cluster and the central urban area. Such high-density passenger outflow provides passenger flow support for the construction and operation of rail transit.

The road network in the central urban area of the cluster city bears most of the traffic volume of the cluster structure city, which causes serious traffic congestion in the traffic corridor of the cluster city, especially in the central urban area during the rush hour. Therefore, urban rail transit with cluster structure should closely connect all clusters to shorten the time distance between clusters, and provide convenient links for long-distance commuting between the edge clusters and the central urban area. In addition, due to the insufficient land for roads in the central urban area and the heavy traffic load, the density of the rail network in the central urban area should be increased. The overall scheme of rail transit lines and stations should rely on the main passenger flow corridors of the city, covering the key areas and important passenger flow distribution points in the city's recent planning.

For the situation that the distance between the central urban area of the cluster city and the cluster, between the cluster and the cluster is generally long, and the population along the line is small, in order to meet the demand for medium and long distance passenger flow between the clusters and improve the transport efficiency, the general number of stations is relatively small, and the distance between the stations is large, so the higher design speed is adopted to meet the efficient, convenient and punctual public transport service between the clusters. Take Chongqing as an example, both Line 4 and Line 10 of rail transit are equipped with large station express trains. These trains only stay at stations with relatively large passenger flow, which greatly shortens the time of cross-group flow in medium and long distance, and transfers part of the ground traffic volume.

Of course, as most clusters of cluster cities are newly built industrial parks and urban expansion areas, compared with the central urban area, the initial population density is relatively small, but the long-term population growth is relatively fast, so the density of the rail network of each cluster should be reasonably set according to the actual needs, focusing on the guidance of urban development by traffic, and the construction and operation of the line

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effectively promote the guidance and transformation of the nature of land use along the line, It also serves the passenger flow of public transport. As for the urban rail transit system deployed in each cluster area, it mainly serves the internal traffic of the cluster and undertakes the high-volume passenger transport links between the functional areas within the cluster, mainly for short distance travel[5]. Therefore, it is of great significance to vigorously develop rail transit to connect various groups and groups.

3.3. Accelerate the construction of urban expressway

For a multi-center cluster city, each cluster has its own functions, with close traffic links and high traffic conversion intensity. Solving the rapid traffic links between cross-clusters is the top priority of the coordinated development of land use and transportation, and the solution of its transportation problems should rely on large-capacity rapid traffic. Therefore, it is particularly important to build a rapid transit system that is suitable for urban space[6]. In view of the expressway problems mentioned above, we should continue to increase the number of bridges and tunnels between key clusters, break the natural barrier, and organically connect all regions. In addition, expressway should be built to avoid the central area of the cluster as much as possible, or elevated expressway should be built if conditions permit.

3.4. Optimize cluster layout and reduce invalid traffic demand

The previous proposal is aimed at urban road and traffic management, and the same attention should be paid to the demand side. For each cluster, the urban functions of the cluster should be further improved to meet the needs of people in a short distance, such as shopping, entertainment, education, medical care, etc. So as to reduce the traffic demand across clusters. For the necessary cross-group flow, it is necessary to reasonably design the transfer hub or public transport station according to the specific flow direction and flow volume of personnel to reduce the number of transfer and detour. The factories located in the central urban area should be transferred to other areas of the city, or the freight cars should be staggered. Reduce the number of large trucks passing through the city during the rush hour, and reduce the risk of urban congestion.

4. CONCLUSION: IT IS A SYSTEMATIC PROJECT TO SOLVE THE TRAFFIC PROBLEMS IN CLUSTER CITIES

The traffic problems in the cluster cities clearly appear to be the lack of road resources, the imperfect road network, and the need to improve the level of traffic management. But it also contains comprehensive problems such as the allocation of urban resources, the use of land resources and many other aspects. To deal with this "urban traffic disease", we can not only "cure the headache, cure the foot pain", but also need to dig deeper into the relationship between various influencing factors behind the problem, and find the "optimal solution" of the problem under the influence of comprehensive factors, so as to solve this systematic problem more thoroughly.

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