

Study on Traffic Management Countermeasures Based on Road Network Capacity

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Abstract. Urban traffic is a huge system, the key lies in the management of the normal operation of reasonable and effective measures. The choice of traffic management measures depends on traffic operation status of the overall. In quantitative analysis, network capacity is a characterization of the traffic state key index. In this paper, through the analysis of numerical calculation and capacity of road network, as a basis for determining the traffic management measures. At the same time, it takes Beidaihe district as the road network capacity calculation examples.

Research background

As a branch of management science, Traffic management is mainly in accordance with the actual situation of provisions of national laws, policies, regulations and road traffic, using various means, methods, tools, facilities, scientific and reasonable management measures. Due to the traffic environment is a complex system, the research methods can be divided to the quantitative analysis and qualitative analysis. Between them, quantitative analysis can objectively grasp the actual state of traffic operation, which is the most clear to object, the most intuitive to proceed, the most reliable to result. In quantitative analysis, network capacity is the key index for the traffic operation.

The capacity of road network

Concepts

In general, road network capacity can be defined in two forms.

Concept 1: Ideal network capacity

It is the maximum standard vehicle to service under the ideal road and traffic conditions, which traffic follows the principle of least individual travel cost, in accordance with the land use, road network layout pattern.

Concept 2: Actual network capacity

Based on the ideal real capacity of road network capacity, it is aimed at the inconsistent road, traffic, traffic individual selection principle, to modify, and the results accord with the actual network path for various conditions of the capacity value.

Functions

The main functions of road network capacity can be described as follow:

- (1) To provide the basic parameters for the traffic control and demand management.
- (2) To judge the current situation and the development potential of road network saturation.
- (3) To analysis of the impact of traffic supply situation of social economic system.
- (4) To determine road and intersection.

In summary, to determine the visible network capacity is the basis of research on planning and management city transportation.

Calculation methods

Calculation methods on road network capacity generally includes: the space-time consumption method, the linear programming method, the cut-set method, traffic distribution simulation method.

(1) the method of space-time consumption

For facilities of city road, the resource is limited and relatively stable in a certain period of time. A traffic individual of the traffic flow may occupation of a certain time and space of road facilities, while the other traffic individual can only use the resource of time and space in addition, so have the space-time consumption method. According to the different dimensions of the use of space, space time consumption method has two models, respectively, the 1D and 2D models. Space-time consumption method conceptually clears; form is single; and the traffic and road capacity is also consistent with the classic. But the practical point of view, as a result of the above model, the key parameters (such as: the average travel time of the traffic individual in the calculation period) has obtained by means of investigation, no theoretical support. And the traffic system itself is random and nonlinear, which based on the space-time consumption theory of network capacity model practicability and accuracy have yet to be improved.

(2) the method of linear programming

The target of the linear programming method is calculating the maximum flow of network in the link capacity limit condition. This concept differentiate the space-time consumption method that models are established based on the theory mostly. But according to the constraint condition, it can be divided into the following two categories: given arc capacity and specified the flow and two layers of extreme value model under the condition of OD route.

(3) the method of cut-set

Cut set method is based on the simplified into a graph (digraph or undirected graph) network, using the theory of graph theory and method, calculating the maximum transport capacity. For the method is used the basic theory of the maximum flow and minimum cut theorem, and the actual road network is a more terminal and random open complex system, so the key of the cut set method is how would the actual road network being abstracted into an ideal map with a single starting point and end and how to seek the minimum cut set of network.

(4) the method of traffic distribution simulation

The basic principle of traffic distribution simulation method is the OD traffic. Each equipped is based with all previously distribution (namely the distribution amount added). When the arc reaches saturation, remove it. When the network is divided into sections, the corresponding dividing line is the minimum cut sets and the tired flow is the road network capacity. This algorithm is a kind of method that traffic assignment and graph theory are combined. So the algorithm has advantages and disadvantages of these two algorithms.

Traffic Management Countermeasures

Traffic management with social science and natural science dual attributes, covers the entire transportation system in the management of object. The main contents include: technology management, administrative management, regulatory management, traffic safety education and training, traffic control. The technical management and traffic control are two important methods which obtained the results by quantitative analysis. Traffic management is usually divided into traffic demand management and traffic system management. TSM is a kind of technology management. The main management object is traffic flow. By means of controlling and guiding the traffic infrastructure and the traffic flow reasonably, averaging traffic load sharing, improve the road network transport efficiency and ease the traffic pressure.

The management strategy of traffic system consists of node traffic management, trunk road traffic management and regional traffic management three. Node traffic management refers to the management of traffic node, by taking a series of management rules and hardware control, to optimize the use of traffic node space resources, improve traffic node through traffic management measures ability; The trunk road traffic management strategy refers to a traffic route for the management scope and adopt a series of management measures, it's a kind of traffic management method of optimal use of space resources, improving the efficiency of highway traffic; regional traffic management is the highest form of the city traffic system management, which make the maximum of all the transportation efficiency of whole region be the management objectives. Traffic demand management is a kind of policy management, the main management object is the traffic source, aiming to make reasonable regulation of traffic demand. Among

them, the spatial equilibrium method and time control law is the regulation means more common. The idea achieves in space or time.

As can be seen, index of road network capacity is the key role of the traffic system management.

Example——Traffic Management in Beidaihe district

The calculation of Beidaihe road network capacity

Introduce of road network in Beidaihe district. Beidaihe district, belonging to Qinhuangdao City, is a famous summer resort. Built area is 21 square kilometers, and the land utilization and Road network distribution shows as figure 1.



Fig1. The land utilization and Road network distribution in Beidaihe district

Tab1. The main road basic information

Road No.	Length(km)	widen(m)
1	727.3	24
2	1005	17
3	9057.9	16
4	800.7	16
5	511.6	12
6	1024	12
7	397.7	12
8	455	12
9	857.6	11
10	1158	11
11	3170	11
12	2210.2	11

The current regional road network mainly consists of three parts (The main road basic information is shown in Table 1): The first part is the connecting line of main highway and expressway, including the Beijing Shenyang high-speed Beidaihe connection line, G205 national highway, the coastal road, Haining Road, North Road, Ning Hai Road, new road. The second part is the primary and secondary road of the area which was built, including Lianfeng Road, Lian Feng Bei Lu, Liu Chilun, Jian Qiu Road, East Road, the road, West Beach Road. The third part is the coastal landscape road, including the pigeon Red Road, East Beach Road, beach road.

Calculation of network capacity. Due to space limitations, Beidaihe road network capacity calculation only adopts the idea of space-time consumption method. Takes the formula as follow:

$$Q = \frac{A}{\alpha} \times B \times \frac{C}{E} \times K$$

Where:

Q -- The capacity of road network (pcu);

A -- The total area of regional road network (m^2);

α -- A standard vehicle traveling at a certain speed occupied Road area (m^2);

B -- Circulation coefficient.

C -- Reduction coefficient in Intersection;

E -- Peak hour trip rate;

K -- Road net generalization using coefficient.

Put into the corresponding value, it can obtain Beidaihe district road network daily maximum capacity of 105000 pcu/d. The maximum value should be slightly adjusted according to different situations. Then, the next work is to implement the rational management countermeasures according to the actual traffic flow.

Beidaihe traffic management countermeasures. Beidaihe District, the traffic flow greatly in the travel peak, but in low flow in the other seasons. There are significant seasonal changes of the flow. In July and August, the traffic of the Beidaihe road and urban road inside is crowded. Between these two months, the import volume is about 2500000 vehicles to 2800000 vehicles and the average import volume reaches about 92000 units, the peak the highest import volume rises to 134000, peak hour import is totaled 9800 vehicles.

According to the service level, the regional traffic import volume of less than 80000 vehicles should be technology policy to optimize node, focus on the intersection and timing signal, improve the operating speed of vehicles; when the import amount is between 80000 with 100000, it should take the line control which aims to reasonable evacuation traffic flow, to avoid local sections appear congestion; when the import is more than 100000 vehicles, should take measures to control allover of roadnet.

Conclusion

Road network capacity is the key index of regional traffic management. It should be based on the value as the basic parameters, combined with the actual condition of road network and the service level of road network capacity that road facilities should meet, to determine a reasonable numerical. Then, traffic management countermeasures is established through the comparing of the traffic state of road and network capacity values.

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References

- [1] CHEN Chunmei, REN Futian, RONG Jian. Review of Road Network Capacity [J]. Journal of Highway and Transportation Research and Development, 2002, 19(3): 97-101.
- [2] HAI Yang, Michael G H Bell, Qiang Meng. Modeling the Capacity and Level of Service of Urban Transportation Networks. Transportation Research Part B34 (2000): 255-275.
- [3] CHENG Lin, WANG Wei, WANG Jingyuan, et al. Urban Road Network Capacity, Traffic Planning and Traffic Management [J]. Journal of Highway and Transportation Research and Development, 2005, 22 (7) : 118 — 122.
- [4] LIU Yanxia. The Concept and Research Methods of Road Network Capacity [J]. Science and Technology Information, 2010 (5): 191-192. R.J. Ong, J.T. Dawley and P.G. Clem: submitted to Journal of Materials Research (2003).
- [5] SUN Chao, WANG Bo et al. Research on Urban Traffic Network State Evaluation Based on a Traffic Network State Coefficient [J]. Journal of Highway and Transportation Research and Development, 2011, 28 (5): 113-120.