RESEARCH ON WINTER TRAFFIC CHARACTERISTICS AND COMPARISONS WITH SUMMER TRAFFIC IN HARBIN

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1.Abstract

Winter traffic characteristics are very different from summer traffic characteristics. Because winter continues for half a year approximately in low temperature in Harbin, based on winter traffic characteristics, some special policies and strategies can be constituted and conducted to reduce energy consumption and traffic congestion. The purpose to prompt traffic efficiency can be achieved with analyzing traffic characteristics deeply and making the comparison of traffic in winter and in summer. Traffic investigation, which involved road traffic volume survey, public transportation survey and residents or vehicles OD survey, should be taken in different seasons during certain period in a year.

There are several aspects that are selected according to the city and its traffic characteristics to be discussed in this monograph, such as road capacity, traffic type, vehicle operating speed, public transportation style, etc. Urban area is emphasized instead of rural area, and the corresponding traffic surveys were conducted in urban district.

These winter traffic characteristics are illustrated and compared with figures and charts. At the end of the thesis, the conclusion that improves winter traffic situation is educed. Public transportation is very important in both summer and winter. And some policies and strategies are put forward for traffic improvement in Harbin.

2.Introduction

Harbin is the capital of Heilongjiang province in the north of China and locates in the middle reaches of Songhuajiang River. It belongs to cold temperate zone, has continent climate. Its difference in temperature between winter and summer is very huge, the highest was 36.4 degree in summer and the lowest was -38.1 degree below zero. The maximal frozen deepness in the earth is 1.98 meter and frozen period is over 190 days. The total area is 53068 km^2 square and the built-up area is 191 km^2. Harbin makes up of 7 districts and 12 counties, with total population of 9.68 million, including 3.38 million in urban area and 0.4 million floating population. It is an important open port to the world in northeastern China and plays a significant role in link other parts in northeast Asia and flourishes regional economics. Urban construction has developed rapidly and economic strength has enhanced distinctly since 1978. With an award of 13rd location in “Top 50 Cities in China”, it has become the biggest central city of politics, economics, science and cultures, at the same time, is a transportation center of railway, highway, aviation and water carriage in the north of China.

2. General Transportation Status

Urban transportation has experienced remarkable changes during the past 20 years, with facilities improved, level of management increased and traffic situation became better. But because of rapidly increasing traffic demand, urban traffic may be faced with worst situation. During recent years, urban traffic in Harbin has changed from partial and occasional delay in segment of road or intersection to regional traffic congestion in city central area (CCA) in peak hours. Therefore, traffic management policy and measure has transformed to comprehensive transportation planning, which is basing on system engineering and traffic engineering theories, instead of temporary methods. Urban road system including intersection and traffic control system has been improved gradually.

The quantity of vehicles increased from 87 thousand in 1990 to 183 thousand in 2000, nearly two times. But urban road area extended 26 percent. To accommodate new situation, according to the city developing style, geographic characteristics, current land use and distribution of traffic flow, a modified scheme is put forth for urban road network. This scheme focuses on a road network with two axial roads, four circumferential roads, ten radial roads. Then inner and second circumferential road and part of urban arterials have been constructed, function of road network in CCA is enhanced. Otherwise, traffic congestion don't decrease radically, conflicts between lack of road capacity and extension of mobility, low level of service of public transportation and increasing demand of residents riding, development of urban traffic and severity of environment pollution are still existing.

The objective of urban traffic study is generally traffic in summer. But because Harbin locates in cold temperate zone and has long frozen period, and traffic congestion in winter is more severe than that in summer, study on winter traffic is a very important part of solving urban traffic problem. It is valuable and meaningful to compare traffic characteristics in different seasons for setting down traffic policy. There are several aspects that are selected according to the city and its traffic characteristics to be discussed in this monograph, such as road capacity, traffic type, vehicle operating speed, public transportation style, etc. Urban area is emphasized instead of rural area, and the corresponding traffic surveys were conducted in urban district.

3.Comparison of Winter Traffic with Summer Traffic

Some changes have happened in winter to affect urban traffic. For example, because of icy road surface and low temperature, the activities of residents and the mobility of vehicles were decreased. Gross traffic volume of some urban roads is reduced. And another situation has happened, with bicycle volume decreasing, quantity of passengers by bus increased greatly. This has caused greater pressure to public transportation. At the same time, lower operating speed was, more traffic congestion happened. As a result, traffic congestion is severe and traffic type is different during peak hour in afternoon.

It is climate, temperature, snowfall and ice cover that affect activities of residents and operation of vehicles, further affect urban traffic. To Harbin without a rapid, safe, heavy carriage transit system, winter climate affect urban traffic more deeply, even without an effective snow removal system to protect road surface in winter.

Emission of vehicle contributes to air pollution greatly. It is showed that pollution is lighter when vehicle is running with high speed than low speed. Thus, some measures such as road improvement and better operation situation are helpful to decrease air pollution. Because of snowfall and low

atmosphere pressure, pollution is more severe in winter. This conclusion can be showed by data in Table 1.

It is showed that winter climate affect urban traffic variously, complexly and widely. It is not enough to discover the nature of affect to traffic activities by simple data. Snowfall and ice cover affecting road capacity will be discussed in this paper. And analysis data were collected on different road surface in different seasons. The essentiality is proved once more to construct snow removal system.

Table 1 Atmosphere Quality Report Weekly in 1999

Term \ Period	9, Dec–12, Dec	15, Jan–21, Jan	12, Feb–18, Feb	11, June–17, June	9, July–15, July	13, Aug–19, Aug
SO_2	0.026	0.06	0.113	0.023	0.030	0.019
NO_X	0.035	0.088	0.086	0.040	0.039	0.037
TSP	0.217	0.321	0.434	0.289	0.206	0.168
Air pollution index	77	111	167	97	74	64
Main pollutant	TSP	TSP	TSP	TSP	TSP	TSP

4.Analysis of Road Segment Capacity in Winter and Summer

There is snowfall and ice cover in some extent. In natural condition, snow or ice on road surface is not removed rapidly, running vehicles would slow down immediately. With great snowfall and long low temperature period, a thin icy layer will be left on road surface after manual snow removal, so friction index is very poor between tyres and icy road. Therefore, running speed can not reach design speed, this cause that capacity and level of service decreased greatly. When vehicle runs at design speed, it is dangerous to vehicle, because road design indexes can not meet demand of running speed on icy road surface. Comparison of capacity of road segment will be discussed as below.

There are two methods to research on road or lane capacity, one is theory analysis method, the other is experience method. In perfect road and traffic condition, the former firstly confirms quantity of vehicles road can deal with (i.e. basic capacity). Then according to practical condition, basic capacity should be adjusted and possible capacity would be induced. The there analysis means are static headway analysis, dynamic headway analysis and survey headway analysis. To compare the difference of capacity between seasons, results of formulation and survey data are analyzed.

The formulation of calculating capacity in static headway analysis as the follows:

$$N_B = \frac{1000V}{l_0 + \frac{V}{3.6}t + \frac{V^2}{254(\varphi \pm i)} + l'}$$

where l' —safe distance between two vehicles after braking，m，usually equal to 5m;

l_0 —length of vehicle，5.0m by car，7.0m by truck;

V —running speed，km/h;

t —reaction and brake time for driver，1.2s in summer，2.5s in winter;

φ —friction index between road surface and tyre;

i —longitudinal gradient，the ratio of vertical level difference and horizontal distance, upgrade is “+”,downgrade is “-”.

The formulation of calculating capacity in dynamic headway analysis as the follows:

$$N_B = \frac{1000V}{l_0 + \frac{V}{3.6}t + l'}$$

Where the symbols are same as before.

The formulation of calculating capacity in survey headway analysis as the follows:

$$N_B = \frac{1000V}{h_l} \quad \text{or} \quad N_B = \frac{3600}{h_t}$$

where h_l —average headway, m;

h_t —average time headway, s.

Because headways between various type vehicles are difference, uniform type vehicle queue is selected to survey and observe. The segment, which is selected on Hongqi Street, is similar with perfect road and traffic condition. The objectives of traffic survey are car and moderate truck. According to our former research, in icy road surface, friction index of car is 0.16 and friction index of moderate truck is 0.14. In analysis, data were collected on same site in winter and summer.

And average time headways instead of average headways are chosen in analysis, because average headway is very difficult to get. The results of basic capacity calculation in different speed condition are showed in Table 2 to Table 5.

Table 2 Basic Capacity of a Lane for Cars in Summer

Running speed (km/h)	60	50	40	30	20
Static headway analysis	1119	1160	1182	1158	1036
Dynamic headway analysis	2000	1875	1714	1500	1200
Survey headway analysis	2500	2250	1714	1380	—

Table 3 Basic Capacity of a Lane for Cars in Winter

Running speed (km/h)	60	50	40	30	20
Static headway analysis	506	567	637	712	754
Dynamic headway analysis	1161	1118	1058	972	837
Survey headway analysis	—	—	1200	1028	947

Table 4 Basic Capacity of a Lane for Moderate Truck in Summer

Running speed (km/h)	60	50	40	30	20
Static headway analysis	1078	1109	1116	1075	939
Dynamic headway analysis	1875	1744	1578	1363	1071
Survey headway analysis	1532	1440	1500	1309	—

Table 5 Basic Capacity of a Lane for Moderate Truck in Winter

Running speed (km/h)	60	50	40	30	20
Static headway analysis	498	554	618	680	701
Dynamic headway analysis	1118	1070	1005	914	772
Survey headway analysis	—	—	867	837	782

Some conclusions can be conducted by the comparison as the follows:

1.The range of vehicle running speed on urban ice cover road surface reduces. Because of low friction index, vehicle can not move at high speed. So higher running speed (such as 60 km/h, 50km/h) was seldom observed, and corresponding capacity couldn't be work out. The upper boundary of capacity is very limited. In contrast, low running speed was also seldom observed and practice

is pretty high.

2.There are some differences among three means to calculate capacity. The results of dynamic headway analysis are higher than static headway analysis. In perfect road and traffic condition, the results of survey headway analysis are close to that of former and higher than dynamics at high speed. It is showed that good road condition lead drivers to manoeuvre rapidly.

3.Capacity of icy road surface decreases greatly in winter. The results of survey headway and calculated by formulation both decrease greatly. Especially, when moderate truck runs at 40km/h, capacity decreases about 42%. It is showed that big vehicles moving at high speed should keep longer headway, then capacity decrease greatly.

Through the upward analysis, icy road surface would affect traffic significantly. With same quantity of vehicles and road network structure, capacity decreases would deteriorate traffic congestion. This is confirmed by traffic survey data.

5.Conclusions

The characteristics of traffic in winter and in summer are acknowledged by comparison. The discovery of cause to winter traffic congestion is a foundation for solving winter traffic policy and measure. A development stratagem should be put forth.

1.Urban transit system have priority to be built up, public transportation should be developed greatly. It will improve surface transportation situation.

2. Based on science and technology means, an effective snow removal system should be constructed. Some foreign advanced technology should be introduced to solve icy road surface problem and eliminate affect to traffic.

3.Traffic study should be close to traffic management. Study should pay attention to the characteristic of winter traffic, and adapt to seasons. The operation of study should be easy and practical, and have close relationship with traffic management.

4.To improve traffic environment and develop coordinately. Focusing on severity of winter traffic, management should be enhanced and low pollution vehicle should be adopted.