Study on Signal Intersection Traffic Flow Characteristics in Ice Conditions

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***Abstract*—As the component of urban transportation network, the intersection is the main part of traffic accidents and the bottleneck of restricting the smoothness of the transportation system. There are signalized intersection and non-signalized intersection, and the former is the main form at the intersection. So the evaluation of the service level under ice and snowfall conditions is significant. In the paper, we analysis the basic parameter of intersection signal control and operating characteristics of straight, right turn, left turn traffic flow in ice and snow condition, and we propose a traffic delay time model. On this basis, according to the snowfall intensity and respectively to the lanes and the whole intersection traffic flow as the object of study, we study the average delay in signal intersection in normal weather, slight snow, heavy snow and blizzard. With snow and ice conditions as starting point, the paper calculates the traffic capacities of signalized intersection under various snow and ice conditions. We compare the results of the calculation model and the actual measurement results, finally get the conclusion: the average delay time model can better express the vehicle at signalized intersection, in which the maximum deviation is 16.73%, and only appear once, twice the maximum deviation is 13.58%, and calibrate the snow and cold weather delayed mixed model.**

***Index Terms*—Ice and Snowfall; Signalized Intersection; Signal Intersection; Traffic Flow Characteristics**

I. INTRODUCTION

The flow entering the intersection range from common road, experienced parking queue, queue dissipation, conflict analysis, and then leave the intersection. In this process, the vehicle must be experienced deceleration, braking, parking and starting, acceleration process, increase vehicle waiting and start-up losses [1]. Running state of the vehicle at the intersection of far more than the road running condition is much more complicated and disorderly, thus to ensure smooth traffic orderly through the intersection, it is necessary for signal control of traffic flow.

At present, domestic scholars have proposed various methods to calculate the capacity of signalized intersection under adverse environments and the most typical is the method of reducing coefficient put forward in American Highway Capacity Manual. Based on previous studies, such scholars as Mr. Zhang regard the feeling of drivers as main evaluation criterion under snow-ice conditions and then they integrate this with such factors as road operating capacity, traffic security coefficient and outside wealth condition [2], where delay, control, weather and etc. are main factors influencing the capacity of signalized intersection under snow and ice weathers. Lida and other scholars design the model with relative intensity quantization process to visualize feelings of drivers, and with the assistance of computer programs [3-7], it can vividly describe the process of drivers forming judgments in signalized intersection and their psychological anxiety changes, hence determining the service level of signalized intersection with this as the evaluation criterion. With grey theory system as research basis, other scholars like Li establish the evaluation model with five important indicators like stopping delay and queuing length, and then evaluate the capacity of signalized intersection and its running state based on this model. Such scholars as Peeheux, Zhang and Flannery further study comprehensive evaluation indices for motor vehicle service level in signalized intersection and design the evaluation index system based on this [8]. After collecting data about friction coefficient in different pavements with snow and ice and analysing the braking response time and braking length for drivers to start, stop vehicle on road with snow and ice and to make a turn at intersection, Cheng Guozhu and other scholars finally take the sedan car as example to give out the suggestive value for maximum speed ensuring safe traffic on pavement covered with snow and ice [9-11], thus calculating the capacity of signalized intersection under snow and ice conditions based on this. To sum up, domestic studies about the capacity of signalized intersection under snow and ice conditions have not yet been mature, which is mainly because the psychological feelings and driving fatigue of drivers are difficult for quantitative research [12-13].

The basic parameters of intersection signal control Traffic signal control is the management of the road intersection traffic the most effective way, it by assigning different traffic direction different green time to control the road traffic flow [14], to ensure the orderly flow. Its use can improve traffic safety, reduce traffic congestion. Control includes a series of basic concepts of signal, such as signal phase, signal cycle, phase difference, the green signal ratio. Below is a brief introduction to some of the parameters of signal control.

Fig. 1 show the vehicle choice in intersection. After making measurement and calculation for several times, the paper obtains calibration results of correction

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parameters based on Method of Stopping Line under the condition of snow and ice pavement, which is listed in Table 1 as follows.

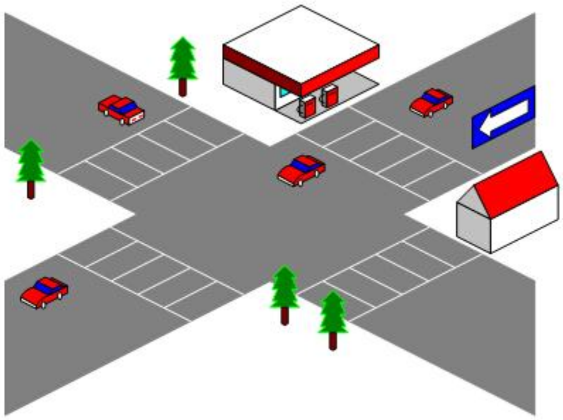


Figure 1. Intersection vehicle choice

TABLE I. PARAMETER CALIBRATION RESULTS IN PARKING LINE METHOD UNDER SNOW-ICE CONDITIOS

Weather	Turning right	Going straight	Turning left
Normal weather	1.0	1.0	1.0
Light snow	0.74	0.78	0.73
Moderate snow	0.52	0.61	0.55
Heavy snow	0.46	0.56	0.49
Snowstorm	0.39	0.48	0.41
Road surface covered with snow	0.64	0.74	0.66
Rough road surface with ice	0.55	0.64	0.57
Smooth road surface with ice	0.50	0.54	0.48
Mixed road surface with snow and ice	0.38	0.45	0.40

A. Signal Phase

Signal phase is a period of the passage of time is divided into two or more times, each time period is called a signal phase, only allow one or more flows to a particular phase of time flow through the inlet, combined display of different direction of different light colors called a ‘signal phase’ [15].

Figure 2 is the two phase signals the most simple, the most widely used control. As can be seen from the graph, this phase of the design did not consider the conflict left turning vehicles and the opposite direction of the vehicle straight. With the in-depth study, people on the left turn lanes were also phase setting, especially in some big intersection, to ensure the smooth running of vehicles [16]. Figure 3 shows a typical four phase signal control chart. The first phase only to give direction to turn left, the other no vehicle; second phase only gives the direction things straight and turn right, other vehicles is prohibited; third phase only gives the north-south direction left, other vehicles is prohibited; fourth phase only gives the north-south direction straight and turn right, other vehicles is prohibited. In order to determine the precision of models previously calibrated for capacity of signalized intersection under snow and ice conditions, the paper now selects the typical “cross-shaped” intersection for investigation, then concludes and systemizes survey data for verification calculation. Then the paper makes calculation according to the data about traffic volume at the intersection between Huaihe Road and Songshan Road. There into, Songshan Road-Huaihe Road is the intersection between primary and secondary trunk roads in Harbin City; furthermore, the former possesses 8 two-way lanes, so does the latter. The place of intersection in-lane is broadened to 5 lanes. As the signal control cycle time is 134s and the signal timing phase is 4-phase timing, there into the phase of green light for going straight in south-north direction is 35s and that in east-west direction is 25s. As the left-turnings in east-west direction and south-north direction separately set up independent phases, the green light time is respectively 20s and 25s, and the yellow light time for going straight and turning left is separately 8s and 9s; right turning is not restricted by the signal light.

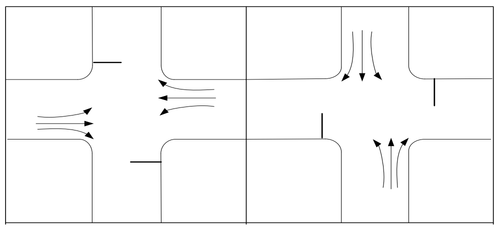


Figure 2. Two signal phase

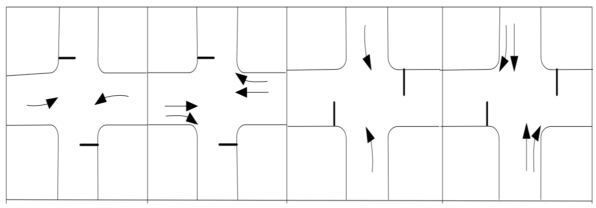


Figure 3. Four signal phase

B. Signal Cycle

Signal cycle length of not less than 36 seconds, otherwise it can not guarantee the direction of the vehicle smoothly through the intersection, may cause the two queues [17]. The two phase of the signal cycle length to a maximum of not more than 120 seconds, otherwise it will cause the driver to wait for irritable or mistakenly think that light color control can not operate normally. Signal cycle is generally expressed by C, in seconds.

C. The Phase Difference

Difference of absolute phase difference and the relative phase difference of. Absolute phase difference (Absolute Offset) refers to the various signal lights (or light) starting point or points relative to a certain intersection (key intersection) signal lights (or light) starting point or the midpoint of the time difference [18]. The relative signal difference (Relative Offset) refers to the adjacent intersection with a phase green light (or light) starting point or the midpoint of the time difference. The relative phase difference is equal to the two signal absolute difference.

D. The Green Signal Ratio

The green signal ratio in a cycle of effective green time of a phase g and signal cycle length C ratio, with lambda said. The minimum green time of pedestrian crossing can according to the time to determine, HCM (Highway Capacity Manual) defines the minimum green time as shown in a formula 1.

$$\begin{cases} g_{\min} = 3.2 + \dfrac{L}{S_P} + 0.824\dfrac{N_{ped}}{W_E} & W_E > 3.0m \\ g_{\min} = 3.2 + \dfrac{L}{S_P} + 0.27\dfrac{N_{ped}}{W_E} & W_E \le 3.0m \end{cases} \quad (1)$$

$g_{\min}$——Minimum green time (s)

L——Crosswalk length (m);

S_p——The average speed of pedestrian crosswalk, approximately 1.33m/sec;

W_E——Effective crosswalk width(m);

N_{ped}——The number of pedestrians cycle interval

If the phase time is less than the minimum green time, you must increase the signal cycle length and phase of time, until the phase time is equal to or greater than the minimum green time, can ensure the safety of pedestrians crossing.

In addition, the control parameters including phase, red interval time and other parameters on the performance of signal intersection, with snow and ice conditions intersection optimization must ice road starting and braking, snow and ice road traffic speed, traffic flow, traffic density and traffic flow characteristic considering the weather.

Based on the cross-shaped intersection and Method of Stopping Line, by analysing and systemizing mass data, and referring to the achievements of previous researches, the paper revises it according to various influencing factors in snow and ice weathers and then gives out the model to calculate the saturation flow rate of intersection lane under snow and ice conditions. To sum up, in order to determine the capacity of signalized intersection under snow and ice conditions, the author should also make clear the correction coefficient on snow and ice pavement for the coefficient is influenced by several factors and it is also very complicated. In consequence, the paper will make detailed research about the correction coefficient of saturation flow rate under snow and ice weathers in the next section.

II. Snow and Ice Conditions in Signal Intersection Vehicle Running Characteristics

A. Straight Movement Characteristics of Snow and Ice Conditions

In general, a straight line is the main way of crossing traffic flow through. Signal intersection in the snow and ice conditions, the straight traffic flow is periodically stopped or by. Vehicles arrive at the intersection, stop and then queue, when the signal is released when the vehicle start, acceleration, and dissipated. Impact on traffic intersection is mainly manifested in the loss of time before the stop line, time losses include loss of time and the loss of time to start cleaning the intersection.

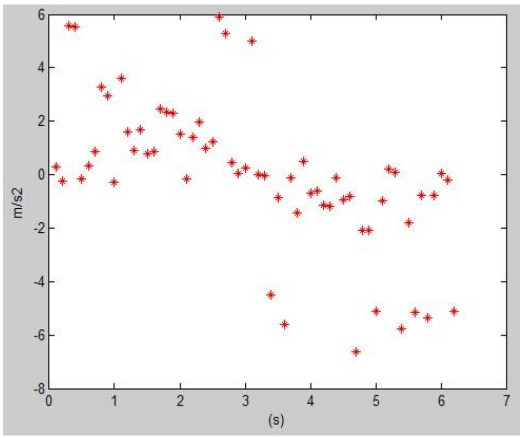
Stable running continuous headway called saturated headway, denoted by hi. But the signal intersection traffic flow is periodically stop, when the signal to change to green, the vehicle starts from standstill, forward, in signal intersection queue front several vehicle headway is higher than the saturation flow headway. Therefore, for the first few cars, from the static start, the headway is higher than the saturation flow headways, therefore should increase its distance, resulting in an incremental, called startup lost time, denoted by L1, is

$$l_1 = \sum l_i \quad (2)$$

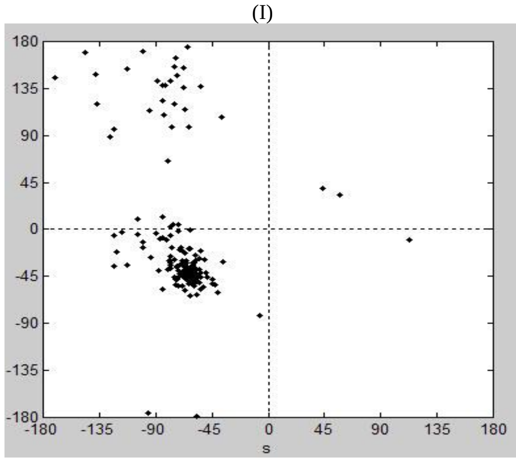
where l_1——Total startup lost time (s);

l_i——The I car boot time loss (s).

Brake under the condition of ice and snow boot has special features, lost time of intersection signal than normal weather conditions will increase. Green initial intersection of straight flow can be divided into four stages as before and after the interrelated and different along the time axis.



(I)



(II)

Figure 4. Spot chart of acceleration rate samples from a practical intersection during the start part of green time

The first stage: the initial acceleration period. Queuing vehicles to get the green light signal, started by a stationary, and accelerating. At this stage, the vehicle according to the spacing itself and the car in front of the adjustment of their acceleration, and close up following queues formed at this stage after the end of.

The second stage: form closely following the queue stage. In this stage, closely following the vehicle queue will continue to increase until stable. During this period, no obstacles in front of the first car, the speed can be increased, so it with second car lengths apart and stimulation of second car accelerated, and then continue to subsequent vehicles to transfer to promote whole queue dissipation.

The third stage: the stage of dissipation queue. At this stage, the first car and second car distance reaches a desired value, after the car began to improve in order to reduce the acceleration of the vehicle in front of the distance, the signal backward continuously transfer, the queue becomes short.

The fourth stage: the free flow speed. In this stage, the car through the intersection, the traffic reduced acceleration, velocity is basically stable, vehicles in order to enter the free driving state, the tightly followed queue disappear completely.

In order to verify the queue formation and dissipation process, selection of acceleration data an intersection, do out of sample plot as shown in Fig. 4.

Clearance lost time L2 refers to one direction from the last car to enter the intersection point and a direction to the time difference between the time the green light. L1 and L2 and called the loss of cycle time L.

B. Ice Conditions Right Traffic Operation Characteristics

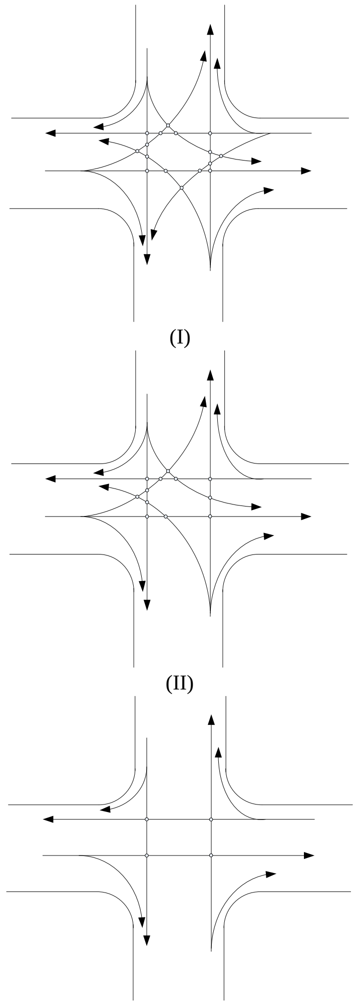
Turn right at the traffic does not produce conflict point in the intersection, so in the snow and ice conditions the main features as time delays, including accelerated loss of time near the intersection of cornering braking and turning.

Snow and ice conditions, when comparing the hours right turn traffic, usually do not need to turn vehicle traffic signal control, the vehicle can be continuous passage in the right lane; if the right turn vehicle and straight line or the left turn traffic share one lane, right turning vehicle may very well be their stop and not be smoothly through the intersection. When the right turn traffic to a certain extent, should give the right turn vehicle traffic distribution in time and space, the necessary time to consider right turn lane and phase of signal set, otherwise it will affect the other direction of traffic.

C. The Left Turn Flow Operation Characteristics of Snow and Ice Conditions

Enter the intersection of the straight flow will be affected by the conflict of different traffic direction, they are at an obtuse angle form through the formation of cross each other, cross when the vehicle collision, conflict point. The research results show that, the conflict point of intersection traffic safety and traffic impact score flow and confluence to.

For cross intersection, all directions are not limited to the left, then a conflict points is 16, as shown in Figure 5 (I); when a direction restriction left, conflict point to reduce 4, as shown in Figure 5 (II); when all directions are prohibited from turning left, conflict point to 4, such as Figure 5 (III) shows.



(I)

(II)

(III)

Figure 5. Conflicting points of crossroads

According to the signal control mode, the left turn flow can be divided into license type left and protected left turn flow. No license type left turn traffic signal phase dedicated, its only in any of the following circumstances can be in the light of time by: 1) to before the straight vehicle conflict does not arrive; 2) in the conflict points nearby and wait for the straight on to the traffic appears to allow through the headway; 3) signal phase change interval time. Thus, the license type of left turn traffic interference straight flow; and protected left turn traffic signal phase dedicated, the traffic features similar to the straight lane.

III. Ice Condition Signal Intersection Vehicle Time Loss

A. Ice Conditions Headway

Signal intersection headway refers to the same lane for two cars in the same site through the stop line interval; reflect the operation status of traffic. When the intersection signal control for the red light, red light vehicle is interrupted, waiting before the stop line. When the light turned green, the vehicles start and run through the intersection. The first vehicle headway is defined as a green light to the front bumper parking line by the time elapsed, second cars headway is defined as the first car bumper through the stop line to second car bumper parking line by the time elapsed, the third car....

Domestic researchers through data acquisition and Simulation of large, the stage of queuing in signal intersection, the 5~6 car after the headway tends to be stable, the first car and second car headway amplitude is the biggest, approximately 2.91s. Figure 6 shows this process, if after fifth cars (N=5), headway tends to a stable value, this value is called the saturation headway.

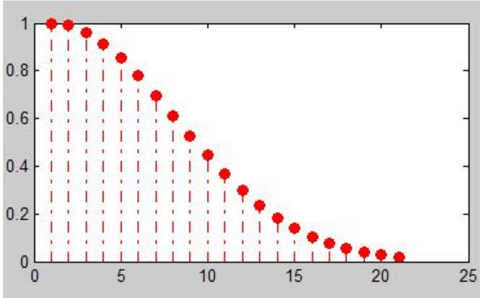


Figure 6. Concept of start-up lost time of the queuing vehicles in signal intersection

B. Ice Condition of Saturation Flow Rate

Signal intersection saturation flow rate is when the intersection signal lights are lights display, in the parking lot behind the line of queuing traffic started forward motion filed across the stop line, numerical flow rate of the lane quickly increased from 0 to a maximum and stable, will this value converted to hourly traffic volume is the saturation flow rate. The definition of "maximum" refers to the number of vehicles parking lines maximum, "stability" means to repeated maximum such "in certain traffic environment". In the ice conditions of saturation, flow rate under the same saturation headway relationship as shown in formula 3.

$$S = \frac{3600}{h_0} \tag{3}$$

C. Ice Conditions Intersection Vehicle Loss Time

A signal cycle, vehicle loss time L intersection includes green vehicle losses early time L1 and yellow Moqing tail loss time l2. Research shows that, with the increase in car ownership, intersection service efficiency decreased at a certain level, city traffic congestion is becoming more and more serious. As you can see from Figure 6, the signal intersection, the sum of single queuing vehicles through the intersection of green initial startup lost time L1 startup lost time to pre N car, as shown in a formula 4.

$$l_1 = \sum_{i=1}^{N} l_i \tag{4}$$

According to the pie chart, the green initial startup lost time can also be expressed as shown in a formula 5.

$$l_1 = \sum_{i=1}^{N} h_i - h_0 \times N \tag{5}$$

Ice and snow weather on intersection delay had significant influence, when ice and snow weather in the snow, snow on the impact strength of intersection delay is not very significant. But from the normal weather by the snow to the snow during this period, intersection delay of vehicles is increasing very fast.

IV. The Traffic Under the Condition of Ice and Snow Travel Time Loss

In the snow and ice conditions, loss of time structure of signal intersection vehicle loss time structure and normal weather conditions are basically the same. The vehicle damage time of these two kinds of state of the difference lies in the increased motor vehicle brake, start time of pavement condition change, increase the driver's visual reaction time, at the same time, pedestrian time safe crossing need increases.

A. The Minimum Safety Distance

The ice and snow road, vehicle speed, road surface friction coefficient is affected, so the safety distance between vehicles than normal weather, mainly in the headway on the increase.

According to the physics energy principle, vehicle arrival braking distance intersection queue according to the road friction coefficient, vehicle speed to determine the relationship, as shown in a formula 6.

$$L_b = \frac{v^2}{2\mu g} \tag{6}$$

L_b——The braking distance of vehicles (m);
v——Vehicle brake speed (m/s);
μ——The friction coefficient of pavement;
g——The acceleration of gravity (9.8m/s^2).

According to the road chapter ice conditions, the friction coefficient, relationship between the ice road vehicle braking distance, as shown in a formula 7.

$$\begin{cases} L_b = \dfrac{v^2}{2\mu g} \\ \mu = -1.05e^{0.38S}\left(0.016t^2 - 0.0218w + 0.052t + 0.843\right) \end{cases} \tag{7}$$

According to the relationship between the headway with head space, relational expression can be shown in a formula 8 get.

$$h_{\min} = \frac{v \times t_r + L_b + L_v}{v} \tag{8}$$

$h_{\min}$——The minimum headway (s);
t_r——Brake reaction time of drivers, 1.7s;
L_v——The length of the vehicle (m).

B. Pedestrians Jamming

In the ice conditions of signal control intersection, then the green light and the traffic flow to form saturated flow, headway is relatively small; the average values are generally lower than 2s. In saturated flow conditions, the pedestrian crossing time required is much larger than the headway, and therefore generally not crossing pedestrian traffic. From the pedestrian interference occurred time, interference more obvious occurred mainly in two typical moment: the first is the green light at the beginning, when the vehicle will acquire the right of passage but not yet obtained the right of way; second is the vehicle to form saturated flow but has not yet formed when saturated flow. In the two period of time, due to the minimum acceptable gap motor vehicle headway easily reach the pedestrian crossing pedestrians, so this will occupy the intersection space, interference or blocking effect on traffic flow.

In the first interference of time, when the lights turn green, there are still some pedestrian crossing, so there is a significant interference on the traffic flow, traffic was hindered for rights of way, so that the loss of the green light time early increased significantly. Second typical interference time or light at the end of the time after the first interference. At the end of the green, the vehicles completely through the intersection, pedestrians will grab the lamp, discontinuous and hinder the subsequent vehicle arrival.

In this two interference time through deceleration road can cause the vehicle and parking, and vehicle speed and the number of parking is affected by how many pedestrians. Therefore, assuming the influence range of each batch of pedestrian is a circle, the circle center position for pedestrians, radius 1m, if two or more than two people together across the road, then take the union.

Therefore, the pedestrian interference loss time t pedestrian as shown in a formula 9.

$$t_p = \Delta t \times n \tag{9}$$

Δt——Snow and ice conditions for each batch of pedestrian disturbing the average time delay;

N——The average traffic interference under the condition of ice and snow a signal period the number of pedestrians.

C. Car Loss Time Model

A signal cycle of snow and ice conditions, vehicle loss time L intersection includes green vehicle loss time L1, early yellow moving tail loss time L2, the yellow light time L3 and time t pedestrian interference. Snow and ice conditions, vehicle loss time increases, the calculation model:

$$L = l_1 + l_2 + l_3 + t_p \tag{10}$$

$$l_1 = \sum_{i=1}^{N} h_i - h_{\min} \times N \tag{11}$$

$$\begin{aligned} L &= l_1 + l_2 + l_3 + t_p \\ &= \sum_{i=1}^{N} h_i - h_{\min} \times N + 3 + l_3 + \Delta t \times n \\ &= \sum_{i=1}^{N} h_i - \frac{v \times t_r + \frac{v^2}{2\mu g} + L_v}{v} \times N + 3 + l_3 + \Delta t \times n \end{aligned}$$

μ——The friction coefficient of pavement snow conditions.

V. THE EXAMPLE ANALYSIS

The friction coefficient of pavement, with snow and ice conditions vary, start, acceleration, braking time lost will be very different. Therefore, in the calculation of the traffic loss time required for classification is calculated according to the different condition of ice and snow.
Calculated according to snowfall intensity, get the traffic time loss calculation formula of concrete, as shown in figure 12.

$$L = \left(\sum_{i=1}^{N} h_i - \frac{v \times t + \frac{v^2}{2\left[-1.05e^{0.38S}\left(0.016t^2 - 0.0218w + 0.052t + 0.843\right)\right]g} + L_v}{v} \times N + 3 + l_3 + \Delta t \times n \right) / n \tag{12}$$

Through data collection and the (12) calculation, the results are as shown in the following table 1.

It is seen from Table 2, model calculation of vehicle loss time values are larger than the field measured values, this is because the model of pedestrian delay estimate inaccuracy caused by. Pedestrians crossing the road when sometimes three five together, this model may repeat the calculation, increase the braking time, so the numerical model is larger, less accurate at the same time the field measurement will be randomly for this result. Also can learn from the table, compared the calculation results with the actual measured results, the maximum deviation is 10.88%, not more than 11%, so that the model can better reflect the snow and ice conditions intersection vehicle loss time, average vehicle delay of all approaches such as shown in Table 2.

Table 2 and Table 3 can see comparison table, calculated values exist deviation with the actual observation, but the deviation most within 15%, except the red flag Street - Huaihe road in the snow weather of the south entrance deviation is 16.73%, can accept the average delay time model can better express the vehicle at signalized intersection. When calculating the average vehicle delay time, the import channel is calculated separately, and field observation the difference between the value of relatively large calculation model, and the whole intersection are put together the calculation value and field observation, the difference between the value of relatively small computational model. The reason for this situation is in the sample size, the more the calculation of sample, the response characteristics of the overall.

TABLE II. CALCULATED RESULT OF VEHICLE LOST TIME IN SIGNAL INTERSECTION

Weather	Songshan Road – Huaihe Road			Hongqi Street – Huaihe Road		
	Calculated/s	Measured/s	Deviation	Calculated/s	Measured/s	Deviation
Normal	2.31	2.16	6.94%	2.37	2.25	5.33%
Slight snow	3.26	2.94	10.88%	3.06	2.87	6.62%
Snow	4.24	4.33	-4.85%	4.09	4.33	-5.62%
Heavy snow	5.01	4.81	4.16%	4.89	4.8	-8.96%
Blizzard	5.33	5.59	-4.29%	5.95	5.54	7.40%

TABLE III. CALCUATION RESULT OF VEHICLE LOST TIME IN SIGNAL INTERSECTION AT ALL LANES

Weather	Enter port	Songshan Road – Huaihe Road			Hongqi Street – Huaihe Road		
		Calculated/s	Measured/s	Deviation	Calculated/s	Measured/s	Deviation
Normal	East	2.13	2.02	5.45%	2.26	2.16	4.63%
	South	2.38	2.15	10.70%	2.42	2.32	4.31%
	West	2.46	2.11	16.59%	2.25	2.08	8.17%
	North	2.39	2.36	1.27%	2.49	2.43	2.47%
Slight snow	East	3.23	2.84	13.73%	3.02	2.93	3.07%
	South	3.06	2.96	3.38%	3.14	2.69	16.73%
	West	3.15	3.04	3.62%	3.07	3.02	1.66%
	North	3.29	2.93	12.29%	3.13	2.84	10.21%
Snow	East	4.28	4.14	3.38%	4.38	4.27	2.58%
	South	4.52	4.39	2.96%	4.32	4.42	-2.26%
	West	4.3	4.41	-2.49%	4.32	4.38	-1.37%
	North	4.59	4.36	5.28%	4.64	4.26	8.92%
Heavy snow	East	5.27	4.64	13.58%	5.17	4.82	7.26%
	South	5.14	4.85	5.98%	4.96	4.68	5.98%
	West	4.84	4.94	-2.02%	4.99	4.83	3.31%
	North	4.97	4.79	3.76%	4.77	4.86	-1.85%
Blizzard	East	5.92	5.83	1.54%	5.98	5.89	1.53%
	South	5.84	5.97	-2.18%	5.64	5.74	-1.74%
	Weat	6.03	5.91	2.03%	5.78	5.83	-0.86%
	North	5.85	5.63	3.91%	5.93	5.71	3.85%

TABLE IV. COMPREHENSIVE FACTORS COEFFICIENT CALIBRATION IN SNOW AND ICING

Weather	Normal			Snow road			Rough ice surface			Smooth ice road			Ice and snow road		
	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c
Normal	0.5	0.5	0	0.5	0.38	0.43	0.5	0.31	0.74	0.5	0.25	0.95	0.5	0.17	1.62
Slight snow	0.44	0.5	0.28	0.42	0.36	0.62	0.41	0.29	0.94	0.39	0.26	1.24	0.39	0.14	1.82
Snow	0.35	0.5	0.65	0.31	0.31	0.95	0.36	0.3	1.38	0.32	0.22	1.68	0.34	0.15	1.97
Heavy snow	0.21	0.5	0.95	0.23	0.29	1.32	0.23	0.27	1357	0.24	0.23	1.84	0.25	0.13	2.14
Blizzard	0.12	0.5	1.2	0.14	0.28	1.69	0.15	0.24	1.84	0.11	0.21	2.07	0.14	0.15	2.69

When the snow and frozen at the same time, need to consider the effect of visibility and coefficient of friction on the crossing time loss, after a lot of data regression, snow and frozen at the same time, visibility and influence of friction coefficient to intersections between loss when approximately a linear relationship, such as shown in formula 13, wherein said the comprehensive influence factor (undetermined coefficient a, B, C value data regression according to different types of ice and snow weather), the average vehicle loss time in single point control relationships such as shown in formula 14, after analysis, the coefficients were suggested as table as shown in Table 4.

$$\wp = a\phi + b\mu + c \tag{13}$$

$$\begin{aligned} L &= l_1 + l_2 + l_3 + t_p \\ &= \sum_{i=1}^{N} h_i - h_{\min} \times N + 3 + l_3 + \Delta t \times n \\ &= \sum_{i=1}^{N} h_i - \frac{v \times t_r + \dfrac{v^2}{2\wp g} + L_v}{v} \times N + 3 + l_3 + \Delta t \times n \end{aligned}$$

VI. CONCLUSION

After the basic parameter of intersection signal control, operating characteristics of straight, turn right, left turn traffic flow were analyzed according to the characteristics of traffic intersection, and to study the traffic loss of time, has been the impact of weather on traffic delay time model. On this basis, according to the snowfall intensity was studied. The average delay in signal intersection vehicle normal weather, slight snow, heavy snow, blizzard, respectively to the lanes and the whole intersection traffic flow as the object of study, and the results of the calculation model and the actual measurement results are compared, finally get the conclusion: the average delay time model can better express the vehicle at signalized intersection, in which the maximum deviation is 16.73%, and only appear once, twice the maximum deviation is 13.58%, and the snow and cold weather delayed mixed model were calibrated.

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