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RESEARCH PAPER

Analysis of the Characters and Strategies of Road Transportation Safety in the Cold Region of China

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Abstract: This paper focuses on the situation in the cold region of China where the transportation safety management of road is passive and negative, the coordination between managements is poor, and the efficiency of emergency rescue is low in snow-icing weather. It also analyzes the characters of road transportation safety in snow-icing weather, and summarizes the national and foreign disposal strategies to deal with snow-icing traffic. Then three effective strategies that can reduce the impact on road transportation safety by snow-icing weather have been received, including the provision of information, traffic control, and dealing with the snow-icing. The paper also discusses the effect of each strategy from the perspective of road maintenance managers, emergency managers, traffic managers, and road users. It will be helpful to improve the operations of road transportation safety in snow-icing weather in the cold region of China.

Key Words: character of road transportation safety; snow-icing traffic; manage strategies; cold region

Introduction

Traffic safety problem in cold region attracts more and more attentions. In winter, the terrible road environment increases the probability of crash in cold regions. Several countries have got certain achievements in this field. Most of these research show that the probability of crash increases sharply in the icy road[1−4]. Perry and Symons presented that the death rate increases by 25% and the accident rate increase by 100% in the icy roads[5]. At the same time, some research indicates that the damage is lighter than the common road because the speed of vehicle is decreased in the icy road.

1 Effect of weather on road transportation safety

Rich research achievement in the investigation of different environments on the road transportation safety has been acquired, and obviously, the results are quiet different. Almost all literatures show that the probability of vehicle collisions and scratching incidents are significantly rising on snow-covered roads[1−9]. British scholars, Perry and Symons' study points out that the accident casualty rate has increased 25% and the accident rate has increased 100% under icy road conditions in Britain[5]. On the other hand, some research literatures indicate that the injury of traffic incident is generally considerably milder under icy road conditions than non-icy road condition, mainly because of the vehicle speed decrease on icy road[2,10].

American scholar Khattak *et al*. draws the conclusion by the comparison analysis of accident data in 54 snowfall regions that 5.86 collisions occur in a million vehicles per kilometer[7]. However, the accident probability is only 0.41 under non-snow condition during the same period and the difference is as high as 13 times. Maze *et al*. have also reflected the outstanding impact of snow, visibility and wind speed on the occurrence potential of accidents[11]. In low visibility (less than 1 km^2) and high speed (greater than 40 km/h) cases, the probability of vehicles collision and scratching is of 25 times when compared with that in normal weather conditions.

Tables 1 to 3 list the achievements in the impact of weather

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factors on road safety[11]. From Table 2, it can be seen that about 21% of collisions and scratching accidents occur in winter, among which only 5% occurs during the snow condition by further analysis. However, the total accident number decreases by 14% in snow weather as compared with normal weather condition. This is mainly attributed to the lower speed brought by the snowfall.

To determine the road transportation safety characteristics under snow-icing road condition in the cold region of China, traffic flow features are investigated by repeated observations and experiments, and the contrast result of the road transportation safety characteristics is shown in Table 4 using the conventional survey methodology of traffic flow parameters and the MATLAB analysis software.

From Table 4, it can be seen that the value of traffic operations generally declines on road covered by ice or snow, which is the same as the research done abroad. However, there is no significant difference in the observed characteristics of traffic flow in icy weather, unlike that in the United States.

Table 1 Free-flow speed for different weather conditions

Weather condition	Recommended value (km/h)	Weather condition	Recommended value (km/h)
Clear and dry	120	Heavy rain	100
Light rain and light snow	110	Heavy snow	70

Table 2 Iowa crash history (1996–2000)

Vehicle type	All crashes			Winter weather crashes			
	Crashes	Average severity	Average loss	Crashes	Percent of total	Average severity	Average loss
Commercial vehicle	22,048	13.6	$ 38,103	5,487	25%	11.8	$ 34,223
All vehicles	342,732	9.4	$ 19,374	71,879	21%	8.1	$ 16,770

Table 3 The average impact of weather on freeway capacity and speed

Weather variable	Intensity	Capacity (veh/h)	Percent reduction compared to clear	Speed (MPH)	Percent reduction compared to clear
Rain	0	2318		106.5	
	0−0.254 mm/h	2272	2%	104.4	2%
	0.254−6.35 mm/h	2152	7%	102.4	4%
	> 6.35 mm/h	1992	14%	100.1	6%
Snow	0	2318		106.5	
	<= 1.27 mm/h	2220	4%	102.0	4%
	1.524−2.54 mm/h	2117	9%	97.7	8%
	2.55−12.7 mm/h	2064	11%	96.4	9%
	> 12.7 mm/h	1801	22%	92.1	13%
Temperature	> 10 ℃	2293		108.9	
	10 ℃−1 ℃	2269	1%	107.5	1%
	0 ℃−(−20 ℃)	2259	1%	107.5	1%
	< −20 ℃	2099	8%	106.7	2%
Wind speed	< 16 km/h	2334		109.3	
	16－32 km/h	2309	1%	108.8	1%
	> 32 km/h	2300	1%	108.1	1%
Visibility (fog)	> 1.6 km	2342		112.3	
	1.6−0.816 km	2115	10%	104.8	7%
	0.816−0.4 km	2069	12%	104.3	7%
	< 0.4 km	2096	11%	99.1	12%

Source: the data of Tables 1to 3 are from Ref. [11].