

RESEARCH STATUS OF SNOW CLEANING TECHNOLOGY

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Abstract: The technological status of snow cleaning and anti-skid on the road was summarized. The characteristics, the advantages and disadvantages, and the use and usages of different chemical snow melting agent were introduced in detail. And the developing tendency of chemical snow melting technology was predicted.

Key words: snow cleaning; snow melting agent; researching status

1 INTRODUCTION

For ensuring a safe, fast, comfort, smooth traffic environment and relieving hazard by snow on road, snow removal is one of important road maintenance work in winter. Therefore, people pay more attention to intensifying snow cleaning, exploiting snow melting agent and antifreeze products in order to ensure traffic safety.

2 Methods of snow removing and anti-slip

With development of transport and communication, and insuring smooth and safety on road, snowy countries and regions such as North America, North Europe, Japan and China etc. have put lots of human and materials to relieve hazards of snow and ice since 1990s. They have explored many effective ways of snow and ice removal. According to the operating mechanism, these methods could be divided into three types: physical antiskid, chemical snow melting and mechanical snow removal.

2.1 Physical antiskid

Physical antiskid is a method of bestrewing a amount of minerals of antiskid materials on the surface of ice and snow, which will enhance its friction coefficient to eliminate the hazards caused by ice and snow. The mineral antiskid materials include all kinds of gravel and slack, whose particle size should not exceed 5mm and in which content of clay and dust is not more than 2~3%. Some contaminated or brittle materials are proper for use. Sometimes antifreeze is added into these materials to avoid freezing between the ice and mineral at stored time. The antiskid materials could be bestrewed by manpower or special machinery.

2.2 Chemical snow-melting

The principle of this method is to reduce the freezing point through bestrewing certain chemical substance (snow melting agent), which could melt ice and snow and prevent

freezing. The snow melting agent, which is in solid or liquid forms, mainly is comprised of NaCl, CaCl₂ and MgCl₂ and so on. Nowadays chemical snow melting is the most popular and promising all over the world for its easy operating and good snow removing, especially at air temperature above -20 °C and less snowfall. But some chemical materials have erosive attack on concrete member.

According to the statistics from 1990s to now, the world has an increasing demand for snow melting agent and the annual demand is more than 30 million tons. Among them, Japan needs 50~60 thousand tons every year. China is not an exception. Beijing, the capital of China, has an increasing demand on snow melting product with years listing in table 1^[2].

Table 1 Amount and use time of snow melting saltwater in Beijing from January 1998 to January 2001

use time	Amount(t)
Mid-January 1998 (48h)	4100
November 21,1998 (6h)	885
January 3~5,2000	4370
January 5~7,2001 (~50h)	10000

2.3 Mechanical snow removal

Mechanical snow removal uses special machines to clean the snow directly, so as to relieve the hazard caused by the snow. There are three types of widely used snow removal machine, namely moldboard style, peeled-style and rolling sweeper.

3 CHEMICAL SNOW REMOVAL TECHNOLOGY—SNOW MELTING REAGENT METHOD

Chemical snow removal is an efficient snow-melting and anti-freeze way, which has some advantages superior to physical anti-slip (short life cycle, road pollution) and mechanical snow removal (poor cleaning rate, pavement damage). The principle of this way is using snow-melting agent to decrease the freezing point of water. Snow will melt at snowing and after snowing when using snow-melting agent.

3.1 Types of snow-melting agent

At present, the products of snow-melting agent have three kinds: (1) traditional snow melting materials: sodium chloride, urea; (2)

second generation of snow-melting materials: calcium chloride, magnesium chloride or their compounds with sodium chloride; (3) newly developed snow-melting materials: CMA(calcium magnesium acetate compounds), ethylene glycol, etc. The physical properties of these snow-melting agents are listed in table 2.

It can be seen that sodium chloride or mixture of chloride salt as snow-melting materials has good effect, wide application and low price. But they have erosion on the road.

The compound of acetate calcium and acetate magnesium has the advantages of little corrosion, easy biodegradation and no pollution. But high price has restricted its application prospect.

Although the corrosiveness of urea is low, its direct emission will cause water eutrophication and excessive algae reproduction, which will destroy the environment.

Table 2 Property comparison of snow-melting reagents

Name	Appearance	Freezing point (°C)	Using environment (°C)	General properties	Application status	Environmental pollution and corrosiveness	Ice remove effect	Price
NaCl	Irregular granular	-22	> -10	low deliquescence and efficiency, good persistence	commonly used snow-melting reagent	high	good	low
CaCl	Spherical	-54	> -20	low freezing point, high efficiency, higher deliquescence than NaCl	Relatively large	slightly high	good	slightly low
MgCl	Granular	-32	> -10	high deliquescence and higher efficiency than NaCl, easily refreeze at low temperature	Relatively large	relatively high	relatively bad	slightly high
NaCl + MgCl	Spherical	-32	> -15	low deliquescence and good snow-melting persistence	Relatively small	slightly high	good	slightly high
CMA	Granular	-12	> -9	high deliquescence, high efficiency, using effect is not good at low temperature	Relatively small	low	good	high
Urea	Micro granular	-12	> -10	low deliquescence and efficiency, not fit using in low temperature regions	usually used at airport and some steel bridge	low	relatively bad	relatively high
Ethylene glycol	Liquid	-40	> -15	high efficient, refreeze at low temperature	Usually used at airport	low	good	high

At the same time, its suitable temperature range is so small, only above -10°C.

Ethylene glycol has the advantages of low freezing point and little corrosion to metals and pavement, but its large BOD (biological oxygen demand) has harmful effects to environment and its high price restricted its use.

Anyway, chloride type snow-melting agent always is used as traditional snow melting product, but it has attracted people's attention to its corrosion to metals and facilities. Therefore, exploiting and producing economical and environmental friendly snow melting agent has become urgent matter of developing snow melting technology.

3.2 Using method

Scientific use of snow melting reagent will not only make it more efficient in cleaning snow, but save the cost of snow melting. Concrete application is as follows:

(1) Spray before snowing

Spray before snowing is a new maintenance technology, which can prevent snow turning into ice by spraying snow cleaning agent before snowing. Their greatest advantage is minimizing the consumption of snow melting reagent, accelerating the speed of snow cleaning, and then relieving the congestion of traffic. The appearance of liquid snow cleaning agent gives the technology more space. After being sprayed on the road, the snow cleaning agent can easily cling to the pavement for its certain viscosity, and it is difficult to volatilize or removed by the vehicles. Spraying time is mainly determined by the weather conditions such as snowfall, wind speed and temperature. The agent is usually sprayed 1~2 hours before the ice appearing. The dosage is determined by the condition of snowfall and the temperature of the pavement. The spray amount can be increased at low temperature, and the snow will melt instantly when the thickness of the

snow is about 5mm. Even if there is a big amount of snow, clinging between snow and road or freezing at the surface of road can be prevented using this method, and then easy to apply mechanical cleaning.

(2) Spray after snowing

Now spraying after snowing is a traditional and common way. There are various shapes of snow even at the same temperature and thickness of snow, so the snow melting ability and application dosage of the agent is different. Spraying agent can take the best effect when the density of snow is as low as possible, namely just as the snow stop, which will avoid waste at the same time. The application dosage of the agent can be adjusted according to the thickness of the snow and the temperature of the pavement. All these can be drawn from the trial.

There is no strict restriction on spraying before snowing or after snowing. It can be determined according to weather, road surface and traffic situations. Both methods can be adopted if necessary.

4 PROSPECTS

Many countries in the world have developed various snow cleaning methods for the impact of snow on modern transportation. Applying snow melting agent has become the most popular method for its advantages. Traditional snow melting agent has the disadvantages of pavement and vehicle corrosion and environment pollution. So some countries like China and Japan have developed some kinds of green snow melting agent, but all haven't been put into large scale application. The snow melting system in the future should includes snow melting agent, related equipments (spraying vehicle, cleaning snow shovel and snow sweeper), weather forecast and environmental monitoring. And then according the weather forecast, we choose the appropriate snow melting agent and snow cleaning equipment for different sections of the road.

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