Current Research on Snow Removal and Ice Control on Roads in Japan

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This report describes various research studies relating to snow and ice on roads in Japan. Some of the results have already been applied in planning, design, maintenance, and operation of road projects. The studies deal with the following: the estimation of the effects of snow depth, topography, and vegetation on avalanche generation; the estimation of snow depth along planned routes, especially in mountainous areas where meteorological observations are not made; the classification of snow on road surfaces and the development of a highway ice information system; the space needed for roadside snow mounds and the design of that space; and the efficiency of different types of snow-removal equipment.

The Japan Islands lying from south to north have considerable differences in meteorological conditions between the south and the north. Accordingly, there is a great difference in quality of snow and ice from region to region. There are many snowbound zones where snow depth usually exceeds 2 m, and it is by no means rare that even housetops are covered.

Japan is located rather low in latitude compared with European nations, so that the surface of the earth is warmed by insolation even in winter. A thin snow or ice film covering the paved surface will likely melt during the daytime.

The large intensity of snowfall, the large amount of snowfall, the abundant insolation, the great extremes in meteorological conditions according to district, and the like constitute the characteristic features of winter weather in Japan.

SNOWBOUND AND COLD-CLIMATE REGIONS

Snow-coverage and cold-climate regions are defined by a law enacted in 1956 for securing the road traffic in cold and heavy-snow areas. A snow-coverage region is defined as the region where the annual mean of maximum snow depth in February exceeds 50 cm. The cold-climate region is the region where the annual mean of temperatures in January falls below 0 C.

Japan has an area of 369,779 km^2 of which 53 and 52 percent respectively are within these defined regions and 61 percent is within both of them. The population in the regions is 25 million.

SNOW AND ICE ON ROADS: STUDY AND COUNTERMEASURES

The history of study and control of snow and ice on roads is very young in Japan. The study and control started about 1962 except in limited areas where it started about 1940. This may be due mainly to progress in arrangement of roads about that time and a rapid increase in traffic in snowy areas as well as a bitter experience of heavy snowfall throughout Japan in January 1963.

Construction of trunk roads has been making headway in those areas, and traffic accidents continue to increase. It is, therefore, required that greater importance be placed on the study of control of snow and ice on roads in the future.

STUDIES CONDUCTED IN JAPAN

To guarantee safe winter road traffic in snowy regions is indispensable to the public welfare as well as to the sound growth of industries and economy in such areas. Snow-

removal projects in those areas are expanding, and techniques employed are improving. It is desirable that effective steps be taken on the basis of general studies on the economy of snow removal from roads, the structures of highways, the properties of snow layers on roads, and snow-removal and snow-protection methods, and so on.

Economic Effects of Snow-Removal From Road

How to evaluate the economic effects of snow removal from roads has been discussed in various ways. Two methods of rating include (a) a macroscopic method that deduces the economic effects from the volume of work accomplished in terms of traffic volume multiplied by traveling time, and (b) a microscopic method that determines the effects in terms of convenience of driving and economy of traveling time due to snow removal. It has been demonstrated that snow removal has notable economic effects regardless of whether they are rated by the first or by the second method.

Geometric Design of a Highway in a Snowy Region

In mechanical snow removal, loading and hauling snow is less efficient than clearing it sideways from the roadway. Therefore, a highway should have surplus width on each side to accommodate such piles of plowed snow. Studies undertaken on this problem have proposed that a surplus width be specified suited to the snow depth on the basis of the shape and density of snow piles. Because the properties of snow differ from region to region, similar studies should be carried out separately for each region.

Properties of Snow Layer on Roads

Efficient snow removal and effective traffic control in snowy regions presuppose perfect comprehension of the properties of the snow layers on roads. Some study has proposed that, through microscopic observation, snow be classified into new snow, powder snow, granular snow, packed snow, and ice film. Further studies on the relationship between the types of snow and the slip of a tire should be conducted. Removing packed snow is particularly important to smooth traffic flow. In this connection, an easy way to clarify the properties of packed snow has been discussed. Such a method will surely help establish objective standards for snow-removal work, which has been undertaken only on the basis of past experience.

Snow-Removing Machines

Selection, combination, and arrangement of snow-removing machines are important. A method to calculate the necessary number of machines of each type was discussed, and new high-performance machines have been introduced. In making a selection, one should consider the conditions of snow and other relevant factors in the area.

Spreading Chemicals

Chemicals, mainly chlorides, are often used to prevent freezing and to melt ice and snow layers on paved surfaces. Reports on methods of using such chemicals and the results of indoor experiments and field tests were examined. New chemicals and new methods of application are expected to be developed soon.

Snow-Removal and Snow-Protection Facilities

There is a growing trend toward an increased use of snow-removing facilities installed along highways instead of mobile snow-removing machines. The installation includes a pipe system through which seawater is pumped. Figure 1 shows the construction of such a pipeline, and Figure 2 shows the system in operation. The intake of seawater and the feed pumps are shown in Figures 3 and 4. Data for designing snow-draining ditches and the practical performance of a road-heating system were also studied. However, many problems must still be solved with these methods.

Data based on model tests are available for designing and arranging snow fences. The application of these data requires that the conditions of the site be investigated.

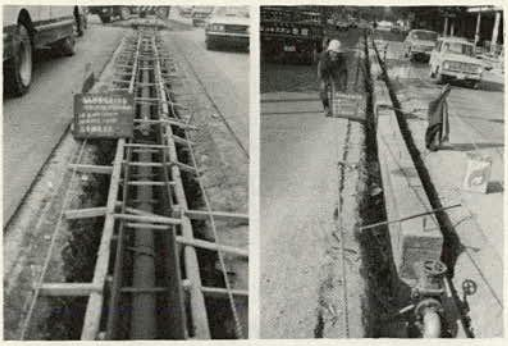

Figure 1. Pipeline being installed along centerline of road; water nozzles protrude from concrete.

Figure 2. Seawater being sprayed on street from nozzles.

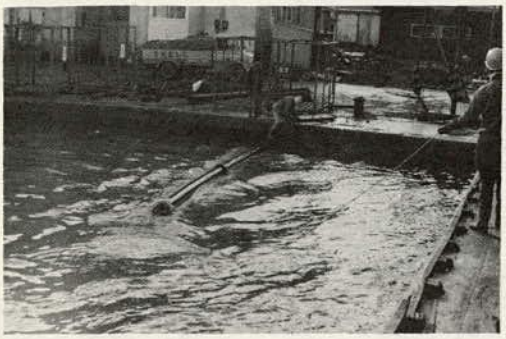

Figure 3. Intake of seawater.

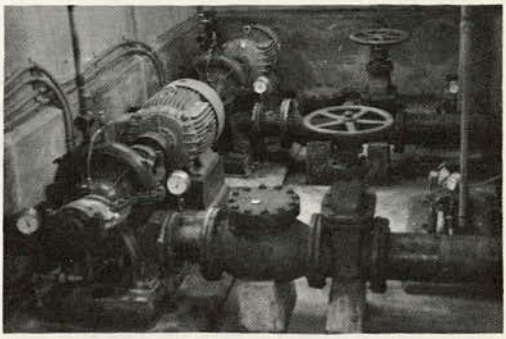

Figure 4. Feed pumps in pumphouse.

Moreover, the performances of fences already installed should be examined before other fences are installed.

There are several methods to protect road traffic from the danger of avalanches. Study has been carried out on criteria for installing facilities, characteristics of existing snowsheds, ways to estimate the probability of avalanches in a given area, ways to estimate the load of an avalanche, and ways to control avalanches such as using explosives and an avalanche gun. Some progress has been made in the research and exploration of avalanche control, but more concrete methods of application should be found to meet diversified demands arising from different traffic requirements, topographical features, and meteorological conditions in different regions.

RESEARCH ORGANIZATIONS

The leading organizations conducting snow and ice research in Japan include the Institute of Low Temperature Science, Hokkaido University, N17 jo, W7 chome, Sapporo; The Institute of Snow and Ice Studies, National Research Center for Disaster Prevention, 9,628 Motoyoshi-sho, Nagaoka, Niigata; Civil Engineering Research Institute, Hokkaido Development Bureau; Railway Technical Research Institute, Shiozawa Snow Testing Station, Japanese National Railways, 1,108-1 Shiozawa cho, Minami-Uonuma, Niigata; Public Works Research Institute, Chiba Branch, Ministry of Construction, 4-12-52, Anagawa, Chiba; and Snow and Ice Laboratory, DoroKodan Shikenjo, Japan Highway Public Corporation, 1,789, Yamazaki cho, Machida, Tokyo.

Informal Discussion

A. G. Clary

How do you keep the seawater system down the center of the street from freezing?

Inoue

The area where the water-spray system is being used is a comparatively warm district. The mean temperature is about 0 C. In the cold regions it is difficult to use this system, but most cities in Japan are in comparatively warm areas.

Clary

Use of the infrared lamp as a de-icing means here in the United States has not proved desirable because of the wind and the reflection of the snow. Is the use widespread in Japan, and is it practical there?

Inoue

In Japan the infrared system is not used very often.

M. E. Volz

I want to make a comment about infrared, because I am sure that everybody is blessed with 20-20 hindsight. We built a new hangar at a cost of about $13 million and installed an infrared heating system inside with the idea that we could de-ice airplanes very rapidly in this building by just pulling them in one side and out the other. The first airplane we pulled in sat there for 38 hours and had not lost any snow by the next day. We decided that either we could paint the tops of all our airplanes black or we could change the heating system. We did the latter.