Goals and Methods of Winter Maintenance in Finland

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Finland is situated so far north that the snowy part of winter lasts for 4 to 6 months. The most important goal of winter maintenance is to ensure the safe and efficient flow of traffic at all times on all roads. Environmental aspects such as the use of salt are also significant issues. To ensure that these goals are met, quality standards for the activities have been established according to maintenance categories. The classification assures the road user that the friction numbers on the winter road surface are kept high enough. Maintenance equipment and its auxiliary devices have been continuously improved. To reduce the need for salt, it is important to remove snow and slush mechanically by plows. When the temperature is between −6 and 1°C (22 and 34°F), salt—liquid, prewetted, or dry—is used for antiskid treatment. Rates as low as 8 to 12 kg/lane-km (30 to 45 lb/lane-mi) of liquid salt can be enough for deicing. Soon Finland plans to reduce the number of miles of main highways that adhere to the bare-pavement policy; main highways with average daily traffic between 1,500 and 3,000 will be evaluated individually to achieve an optimal balance between the users' needs and the environment.

Finland, which is situated in northern Europe between the 60th and 70th parallels of latitude, has 4 to 6 months of snow in the winter, and the depth of snow cover ranges between 40 to 80 cm (15 to 30 in.). On the narrow coastal strip by the Baltic Sea, the winter is shorter and the snow melts several times during the winter. Temperature changes can be sizable and quite sudden. The freezing weather typical of the mid-winter [temperature under −10°C (14°F)] can last from a few days to as long as 2 or 3 weeks. Snow falls on many days during winter, in amounts usually no more than 15 cm (6 in.). The most problematic weather for road maintenance personnel is mild, varying weather conditions, when the temperature varies between −6 and 3°C (22 and 38°F). This is generally when Finland receives the most snow.

OBJECTIVES OF WINTER MAINTENANCE

Despite the long winter, society must keep rolling. Thus, the main objectives for winter maintenance are to

- Ensure the smooth flow of traffic on all roads at all times;
- Provide traffic safety; and
- Minimize harmful effects on the environment.

The standards are grounded mainly in traffic volume–based maintenance classifications; the divisions are given in Table 1. For each maintenance category, a condition standard has been defined, and when the road condition falls short of this standard, it must be returned to the required level within a specified time by means of appropriate maintenance activities. Slipperiness, snowiness, and evenness are regarded as variables of the condition standards. The current standards are based on thorough studies that were carried out in the 1980s. The definitions of the condition standards are given in Table 2. Each maintenance class is defined by a given condition standard. Table 3 shows the target condition values for each maintenance class. It also presents the cycle times, which is the amount of time that is allowed for a road that has fallen short of the condition standard to be restored to the level of its target condition.

Road maintenance tries to keep the main part of the road system within the first maintenance class clear of snow and ice throughout the winter. However, as indicated in Table 2, a thin layer of snow is allowed between traffic ruts. This helps to reduce the use of salt. On these highways deicing is done mainly with sodium chloride, but salt is used only during the most slippery traffic conditions, when the temperatures are between −6 and 1°C (22 and 34°F). The friction is at its lowest during these temperatures. In colder weather the friction is generally good. When the temperature goes below −6°C, deicing is done primarily by using sand with a little salt, but only in the most problematic places such as intersections, curves, and hilly sections of the road. Although salt would be effective at lower temperatures, the limit for using salt has been set at about −6°C to reduce environmental problems. Colder weather requires more salt to be effective.

Correctly timing maintenance measures in changing weather conditions is of primary importance. The Finnish National Road Administration (FinnRA) has a weather monitoring system and night patrol operations at the road maintenance areas designed for this purpose. The road weather service system, which has about 150 road weather stations and covers the main highways of the entire country, provides advance warning of weather changes. Maintenance supervisors have skid testers in their cars, which can be used to assess the need for maintenance measures. Monitoring of the existing conditions as they relate to the condition standards is a central part of the system. The maintenance engineers of the road district monitor quality standards in a centralized way.

FinnRA is very satisfied with the system, but it must improve the dissemination of information to road users; new district information centers are being tested today. The cooperation of maintenance supervisors must be better guaranteed than it is.

ENVIRONMENTAL EFFECTS

In recent years the chloride content of the groundwater has risen in some places because of salting. In the future this may

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TABLE 1 Maintenance Classifications

Class	Traffic Volume (ADT)	Length (%)
I Super Divided	(Freeways)	0.6
I Super	6,000 or more	2.1
I	1,500 to 6,000	11.0
II	200 to 1,500	42.4
III	Less than 200	40.6
IV	(Pedestrian and bicycle paths)	3.3

NOTE: ADT = average daily traffic.

TABLE 3 Target Condition Values and Cycle Times by Maintenance Class

Maintenance Class	Target Condition		Cycle Times (hr)	
	Day	Night	Deicing	Snow Removal
ISD, IS	4	4	2	2.5
I	4	3	2	3
II	3	2	4	4
III	2	1	6	6
IV	2	2	4	4

NOTE: ISD = I Super Divided, IS = I Super.

TABLE 2 Definition of Condition Standards

Quality class variable	Target Value				
VARIABLE I, SLIPPERY CONDITION	1	2	3	4	5
- Skid number	0,00-0,15	0,15-0,25	0,25-0,30	0,30-0,45	0,45-0,10
- Road surface	Very icy driving	Dry ice or	Coarse ice or	Bare and wet	Bare and dry
- Texture	or otherwise very slippery	snow path	snow path in cold weather	or paths between traffic ruts	
II SNOW CONDITION (10, 20 and 30 mm = 0.4, 0.8 and 1.2 in)					
- Dry frozen snow	> 50 mm	≤ 50 mm	≤ 30 mm	≤ 20 mm	-
- Thawing snow	> 40 mm	≤ 40 mm	≤ 25 mm	≤ 15 mm	-
- Slush	> 30 mm	≤ 30 mm	≤ 20 mm	≤ 10 mm	-
- Drifting snow	Easy passage may be difficult some places, car may become stuck in a snowdrift	Projections over the road or moderate snow layer at the road edges, driving speed must sometimes be reduced	Projections here and there over the road, driving speed has to be reduced in some cases	Projections here and there to the middle of the outermost traffic lane, generally no need to reduce the driving speed	
III EVENNESS (10, 20 and 30 mm = 0.4, 0.8 and 1.2 in)					
- Ruts	> 30 mm	< = 30 mm	< = 20 mm	< = 10 mm	
- Other roughness	Path very uneven, possible projecting bumps, driving speed must be reduced and uneven spots avoided	Plenty of worn spots or disturbing holes, driving speed must be reduced in some places	Path even possible unevenness does not actually disturb driving	Thickness of path strips on the road portion under traffic < = 10 mm	

cause problems in providing drinking water to communities. The increased salt concentration of drinking water may be a health risk, at least to some groups of people. It also makes the drinking water taste bad and causes some corrosion damage to the water system. Other negative effects include rust damage to cars and damage to the growth of trees and other plants. To keep the environmental problems at a minimum, the department has

- Considered environmental issues in the development of goals for winter maintenance so as to keep the use of salt at a moderate level;
- Identified risk areas and evaluated the use of salt on those sections on a case-by-case basis;
- Increased the accuracy of salt application and reduced the amounts used by means of new technology and training;
- Monitored closely the use of salt; and
- Systematically followed the impact on the environment.

EQUIPMENT AND DEVICES IN USE

The main principle in the development of equipment and auxiliary devices is to improve the quality and efficiency of winter maintenance work. Such improvements will decrease the time during which the road conditions are below the target standard. The basic unit used on the main road network is the truck. The improved system of hydraulics designed for it provides the driving power for many auxiliary devices. The hydraulically operated auxiliary devices have been developed by FinnRA so that they are suitable and efficient for each road category.

The snow removal activity on the road network that must be kept bare (first maintenance class) primarily includes plowing snow, wet snow, and slush. Salting is often done at the same time. To accomplish that, the truck is equipped with a double-blade plow, wing, and a rear (or liquid) spreader (Figure 1). The snowplow has been developed so that it throws snow very well, and it has also been designed with another blade behind it that is made of rubber (Figure 2). The rubber blade is divided into four parts because of ruts in the road surface. The rubber material and its four-part structure enable

FIGURE 1 Finnish winter fighter with the plow, wing, and liquid salt spreader.

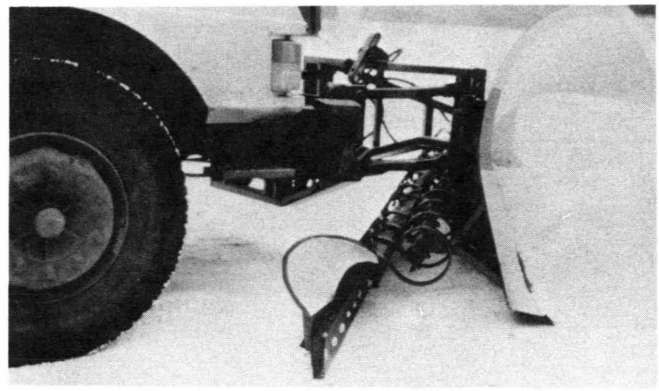

FIGURE 2 Finnish double-blade plow.

the blade to clean the wet snow or slush left by the first blade. A road that is as clean as possible requires less salt than one that has been plowed less efficiently. When dry snow is plowed, it is not necessary to use the second blade, so the blade is hydraulically lifted clear of the roadway. The salt is spread by a rear or a liquid spreader on two lanes at the same time. The truck, however, normally operates on the right lane and salt is sprayed sideways also on adjacent traffic lane.

On road networks of lower maintenance class categories, FinnRA uses the telescope plow, which has an adjustable plowing width and an underbody plow for removing packed snow from the road. Antiskid treatments consist of sand or salted sand.

The hydraulic auxiliary devices are so easy to handle that it is possible for one driver to operate the truck with all three auxiliary devices operating simultaneously on the road.

SALT USE

For environmental reasons, strong efforts have been made to reduce the amount of salt that is spread. As reported, the amount of salt used is influenced by the quality of snowplowing and by the salting methods. The main principle is to salt a road surface that is as clean as possible and to use the right method of application for the conditions.

FinnRA uses liquid, prewetted, and dry salt. Liquid salt is now in extensive use, especially in southern Finland. In the northern regions it is used to remove ice coatings during fall. Liquid salt usually consists of 23 percent sodium chloride.

Sodium chloride is mainly used for dry salt applications. Water, liquid sodium chloride, or liquid calcium chloride is used for prewetting salt. The use of prewetted salt has greatly increased in Finland. Its use is usually possible through the entire winter. A 5 to 10 percent concentration is typical for prewetting.

The amount of salt used in one-time spreading by the different methods is as follows:

Salt	*Amount [kg/lane-km (lb/lane-mi)]*
Liquid	8 to 12 (30 to 45)
Prewetted	20 (70)
Dry	25 to 50 (90 to 180)

The differences in application rates are significant. It should be remembered, however, that liquid salt is suitable only for

preventing ice film or as an antiskid treatment on a very small snow residue. The amount of salt in difficult circumstances can be even twice as much as mentioned (such as in colder temperatures or spreading under snow). However, all these methods are needed to achieve the optimum results for both traffic safety and environmental concerns.

DEVELOPMENT VIEW

In Finland all are concerned about the environmental effects of salting, which is why officials are examining ways to reduce the number of miles of main roads that are kept deiced through the winter. The condition value for roads with average daily traffic between 1,500 and 3,000 will be reviewed. Already on a third of these roads, a lower target condition value of 3 is applied for antiskid treatments, although the value is still 4 for snowiness and evenness. New roads will be evaluated individually to achieve an optimal balance between users' needs and the environment. However, roads must be treated in a unified way throughout Finland so that the standard of traffic safety is consistent and so that the road users are not surprised by a change in conditions.