New Ideas and Equipment for Winter Maintenance in Finland

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New Finnish winter maintenance equipment and methods are summarized. Examples include a station for liquid salt production, liquid salt spreaders for maintenance areas with low traffic volumes, new types of snowplows, the Finnish multifunction road maintenance vehicle, video camera control, an alternative antiskid treatment, and heated-sand tests.

The Research and Development Unit of the Finnish National Road Administration (FinnRA) at Tampere specializes in winter maintenance development, mainly through field tests. Its staff works closely with the maintenance personnel at the road districts and maintenance areas; the unit operates on the basis of work orders from these personnel and central administration. There are three other research and development units at FinnRA; they concentrate on different fields of development. The units exchange information and have contacts with foreign agencies as well.

This paper summarizes the newest Finnish ideas and equipment for highway winter maintenance.

BRINE PRODUCTION UNITS

There are about 40 factory-made units for brine production in Finland. If the self-made models are included, there are about 100 units altogether. Brine is used mainly for liquid salt application but also as a prewetter of granular salts.

Development began when some FinnRA technicians started to plan an efficient and reliable model from the self-made mixing units; some private companies did the same. A maximum production capacity of 60 m^3/hr can be reached now. Small self-made models are still needed for areas with low traffic volumes or just for prewetting (Figures 1–4).

SIMPLE LIQUID SALT SPREADERS AND PREWETTING SYSTEMS

Less-expensive equipment is needed where traffic volumes are low, where only limited stretches of the highways are treated with salt, or where the low winter temperature range prevents the use of liquid in the middle of the winter. Many simple spray bar and spinner spreaders have been developed. They cost about 20 percent of what the most expensive liquid spreaders cost, and they have been shown to be appropriate (Figures 5 and 6).

The salt can be prewetted at the spinner or just before it drops to the spinner. When the prewetting takes place at the end of the screw conveyor, the liquid is better absorbed because of a longer contact time (Figures 7 and 8).

Prewetting with water in a truck is a good method for areas that need only a little salt. The most even wetting result is achieved by spraying water into the salt through a specially designed nozzle. If salt is wetted from above, a few jets of water give the quickest result (Figures 9 and 10).

QUICK CHANGE ACCESSORIES

Quick change accessories and equipment have been developed for emergencies; one example is a brine tank with its own legs. The tank can be easily loaded into the truck. The legs of the tanks are often dimensioned to carry the full load when loading or unloading a truck or when storing liquid. A corresponding system can also be built on a demountable body of a truck (Figures 11 and 12).

SNOWPLOWS

Slush removal is important but difficult if there are deep ruts on a pavement. A dual-blade plow has been designed to take slush away from ruts. The first cutting edge is made of steel, and the second, of flexible rubber. Synthetic materials have also been tested to replace rubber. A good plowing speed is 30 to 60 km/hr (19 to 38 mph), depending on the type of slush or snow. The plowing width is 2.8 to 3.0 m (9 to 10 ft), and the maximum height of the plow is about 1.5 m (5 ft) (Figures 13 and 14).

Extendable hydraulic plows can adjust plowing widths from 2.8 to 3.5 m (9 to 11.5 ft). The extension component can be on the right or left side of the plow. For a left-hand extension, the whole plow moves an equal step to the right. The wing height is 1.2 to 1.6 m (4 to 5 ft), and the plowing speeds are 40 to 60 km/hr (25 to 28 mph) (Figure 15).

UNDERBODY PLOWS

Underbody plows are in extensive use in Finland for removing snow and slush and for leveling softly packed snow layers.

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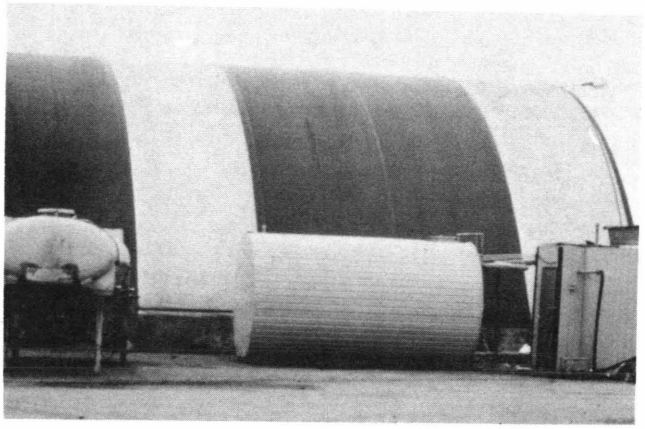

FIGURE 1 Semiautomatic mixing unit with a 10-m^3 mixer and a 20-m^3 storage tank made of stainless steel.

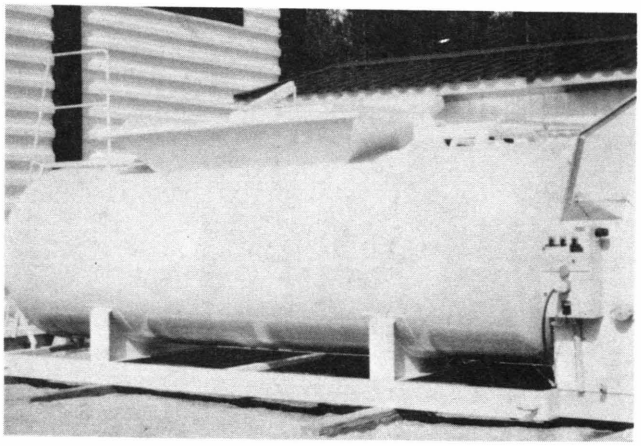

FIGURE 2 Mixing unit for prewetting liquids. Tank is made of epoxy-coated steel.

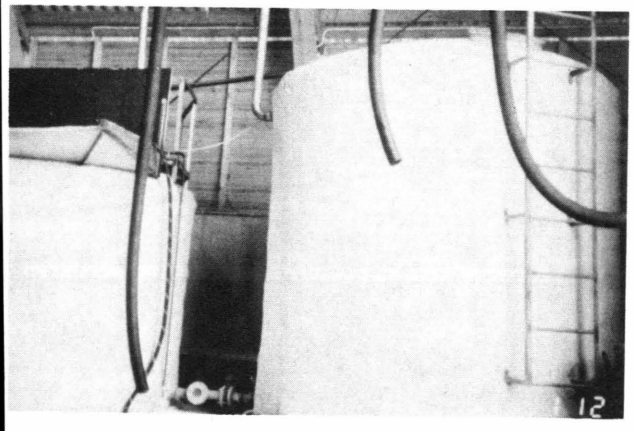

FIGURE 3 Automated mixing unit (10 m^3) with storage tank (20 m^3) made of fiberglass.

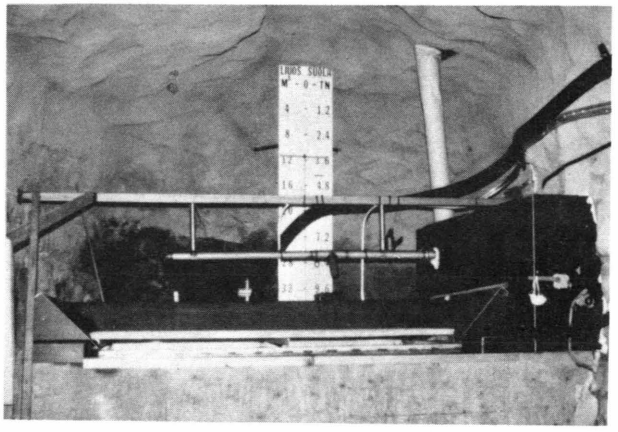

FIGURE 4 Efficient (up to 60 m^3/hr) mixing unit in the rock. Salt and sand are stored in the same cave.

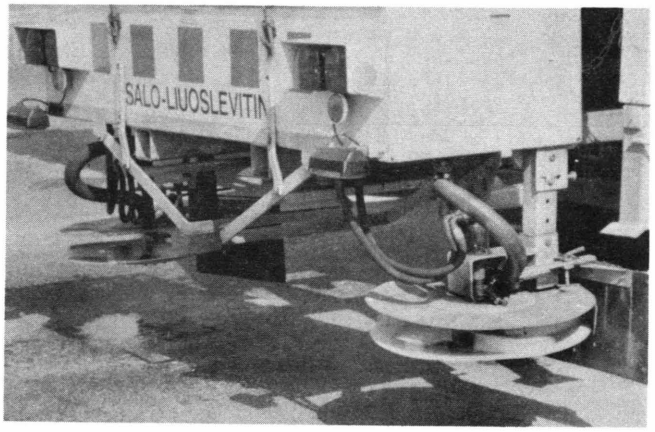

FIGURE 5 Spinner liquid spreader with operating speed of 40 to 55 km/hr.

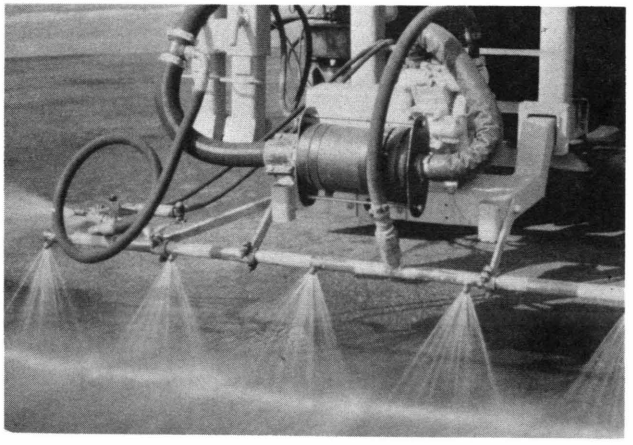

FIGURE 6 Spray bar liquid spreader with operating speed of 50 to 70 km/hr. Solid leg of the tank for full tank handling can be seen.

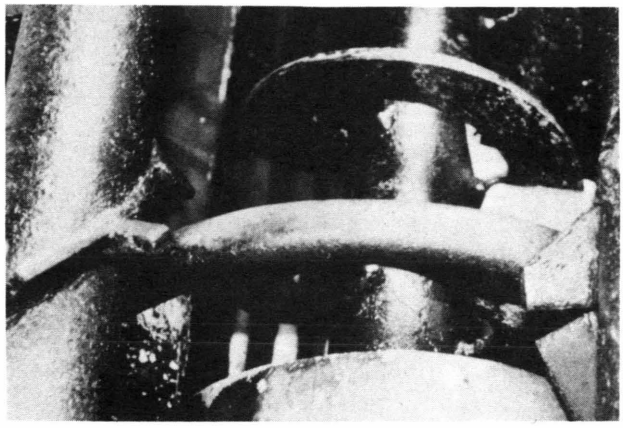

FIGURE 7 Inside view of spinner-type spreader hopper. Prewetting pipe is at end of screw conveyor.

FIGURE 8 Spreader of Figure 7 seen from outside. Prewetted salt is dripping wet. Amount of prewetter is 20 weight percent.

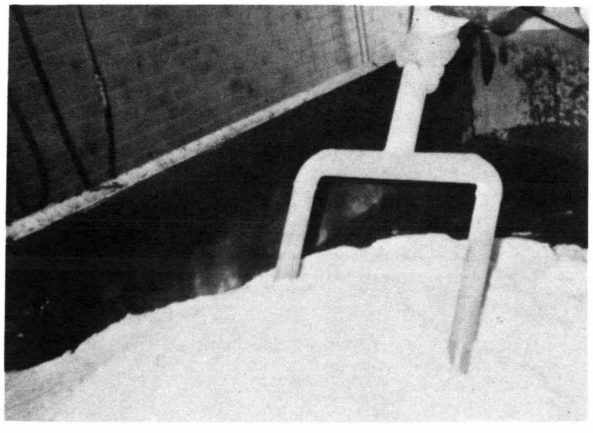

FIGURE 9 Salt can be prewetted in a truck by using a special nozzle.

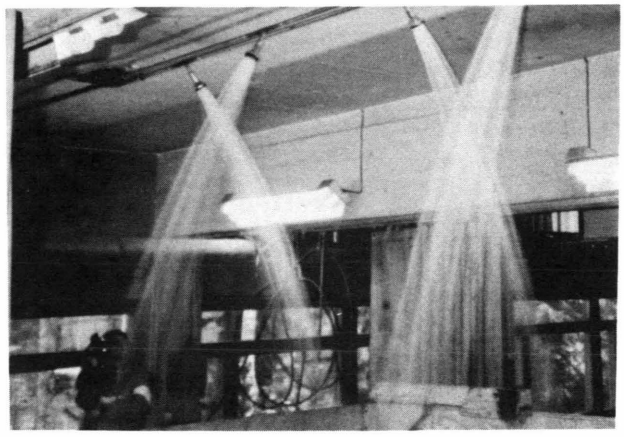

FIGURE 10 Water jets from the ceiling prewet the salt quickly in the truck.

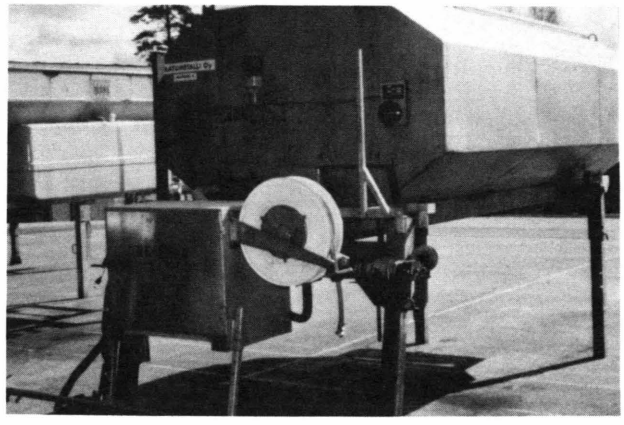

FIGURE 11 Steel tank for storing and transporting liquids. At rear of tank is a spray bar spreader that can be converted to a washer for bridges using a hose. The legs and other structures are often strengthened to allow handling of the full tank.

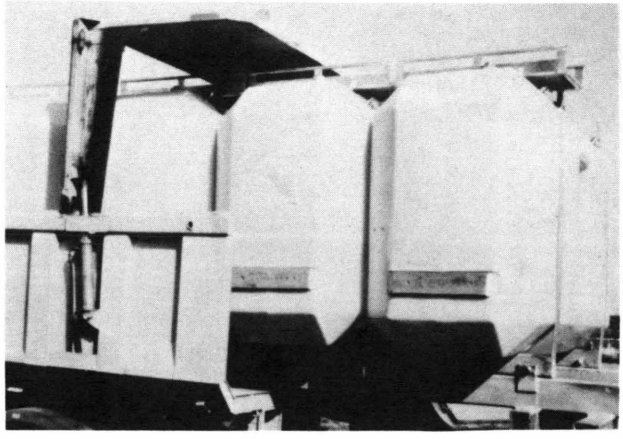

FIGURE 12 Tank system made of glass fiber blocks. Number of blocks is chosen according to the need and space available.

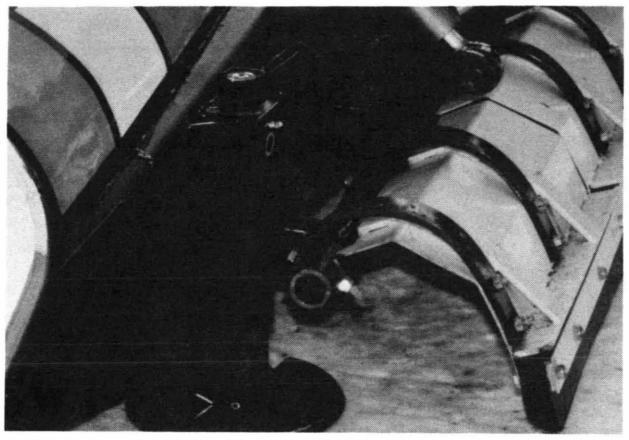

FIGURE 13 Dual-blade plow. The flexible rubber blade is behind the steel cutting edge. This type of a plow meets well the requirements of rutted pavements.

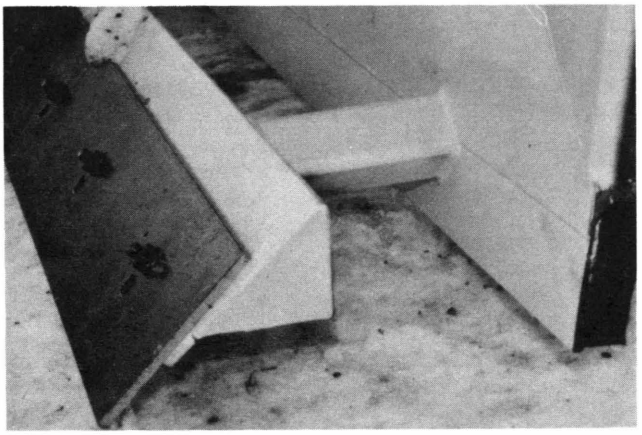

FIGURE 14 Another type of dual-blade plow. The steel cutting edge is set in a fixed outward position.

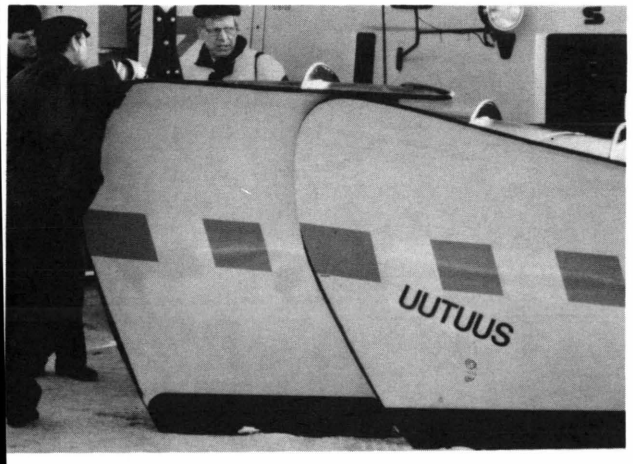

FIGURE 15 Extendable one-way plow. The extension is to the right.

Therefore, the use of motor graders is postponed on the packed snow. All kinds of cutting edges are possible. A side wing can be used at the end of the underbody plow to cast snow further. The plowing speed is 25 to 35 km/hr (16 to 22 mph), and the leveling speed for packed snow is about 20 km/hr (13 mph). The blades of the underbody plows are multipurpose accessories because they can be used for summertime purposes as well (Figures 16 and 17).

MULTIFUNCTION VEHICLE

Different winter activities are often carried out simultaneously. The multifunction vehicle has a one-way plow, a side wing (sometimes in connection with an underbody plow), and a combination spreader. This type of spreader can take liquids and granulars simultaneously and spread them separately or mixed (Figures 18 and 19).

SKID RESISTANCE CONTROL FOR MONITORING LEVEL OF SERVICE

The quality of road conditions is measured all over Finland throughout the winter. The number of evaluations is statistically calculated for 10 percent accuracy. In Häme district a skidometer with a data logger is used (Figure 20). For roads with average daily traffic (ADT) below 1,500, deicing operations should be initiated when the friction coefficient is less than 0.30.

CAMERA CONTROL

Camera control is in experimental use to monitor road conditions and to supplement the information from road weather stations. The requirements for traffic control and road condition monitoring are different. Traffic control requires online information, and low-resolution pictures are accepted. Road condition monitoring works best with high-quality but still frames. Only a few reliable (but expensive) systems were

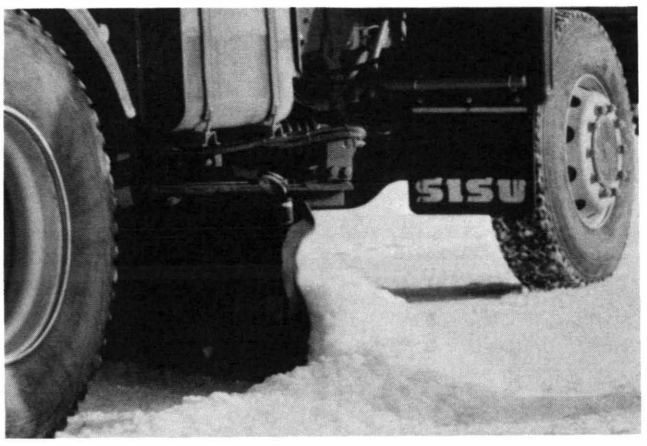

FIGURE 16 Underbody plow leveling a layer of packed snow.

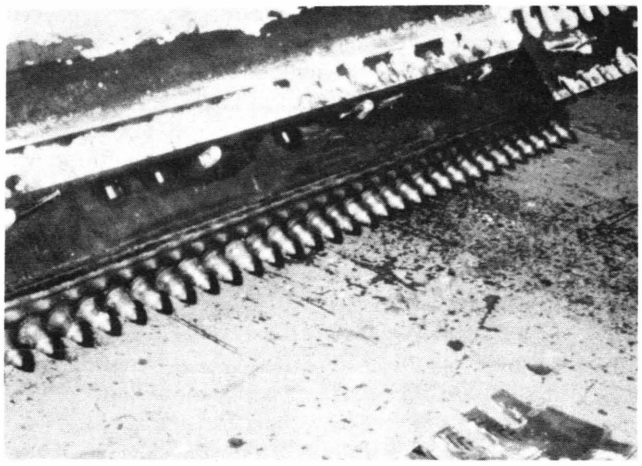

FIGURE 17 All kinds of cutting edges can be used with underbody plows.

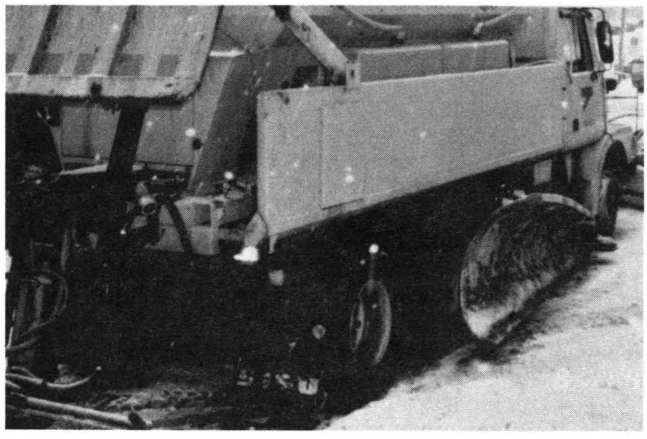

FIGURE 18 Fully equipped maintenance truck with plow, side wing, and combination spreader. Tailgate has a hydraulic control that can be used to decrease the turbulence behind the truck. Tank can be handled through the tailgate.

FIGURE 19 Reversible plow on multifunction truck.

FIGURE 20 Material storage in a rock including sand, granular salt, and mixing unit for brine. Storage is filled from upper level.

formerly available. The new cameras do not need any difficult bidirectional control for fine-tuning the picture. They take clear 640- × 512-resolution black-and-white pictures, in an illumination of only 0.15 lux (Philips) and at night with the help of 300- to 500-W infrared light sources. An inexpensive PC with a high-performance frame grabber (Screen Machine) packs the picture 1:25 and sends it through a communications network or an ordinary telephone line (US-Robotics V.32 bis). The delay time for one picture is 1 min, but only two or three pictures an hour are needed for a sufficient level of control. Full-color pictures are possible without any modification. The picture history makes it possible to extrapolate snowfall rates and such. Almost all equipment and software are off the shelf, so new computer technology will lower the prices dramatically (Figures 21–23).

REINDEER AND CALCIUM MAGNESIUM ACETATE

Reindeer cause more than 4,000 traffic accidents a year in northern Finland. In winter they gather to the highways to

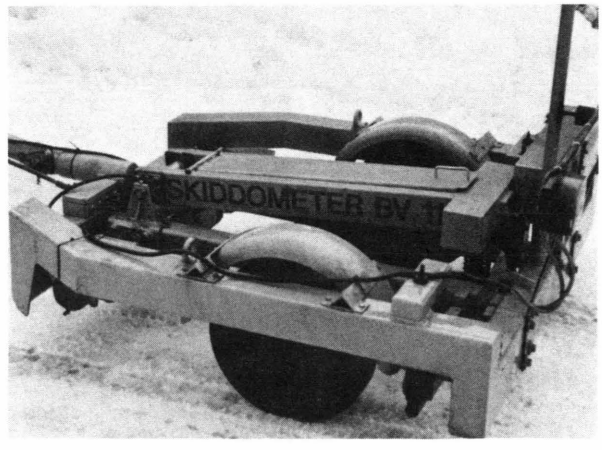

FIGURE 21 The centralized friction measurements collect equal data from different areas.

FIGURE 22 Camera control post in connection of a road weather station. The camera has infrared light for night use.

eat salt mixed with sand. It was assumed that calcium magnesium acetate (CMA) would not attract reindeer because it smells like vinegar. Tests proved this to be so: the reindeer are so eager to eat salt that they must be pushed away with vehicles, but when roads have been treated with a sand-CMA mixture, the reindeer become timid and run away.

ALTERNATIVE ANTISKID TREATMENTS

Sand and Liquid Salt Mixes

Spraying liquid salt onto sand in a truck is done regularly in one maintenance area with positive results so far.

FIGURE 23 Post in Figure 22 is situated in a difficult and remote stretch of highway.

Junction Treatments with Sand and Spray of Liquid

The junctions and interchanges are treated first with salt and then immediately with a spray of liquid NaCl mainly in cold conditions. It has been found that the spray binds the sand well with a usual application rate of 10 g/m^2.

Heated-Sand Field Tests

In January–February 1991, two heated-sand studies were made in the Lappi and Oulu districts of FinnRA. The objective was to study whether the heated sand would stay longer on roadways than sand mixed with small amount of sodium chloride. The ADTs of the study highways were roughly between 250 and 500. The roadways were mainly covered with ice 15 to 20 mm (0.6 to 0.8 in.) thick. During the studies the road surface temperatures varied from about −10 to −20°C (−14 to 4°F).

The best results were achieved in the Oulu district, where the sand was heated using a drying drum at an old asphalt plant. The highest temperatures measured in the truck were about 250°C (482°F).

Even in the best of cases, the measured friction values returned to the initial state within 24 hr. It was shown that sand temperatures must be clearly above 100°C (212°F) to lead to penetration of sand particles and increased friction. Large particles kept the heat, but small ones did not. After some time only large particles could be seen here and there sunk into the ice. For increased skid resistance, fine particles also would have been needed, but they were blown away.

According to the tests, the heated-sand method is not technically feasible for a long-term increase in friction values on ice packs (Figure 24).

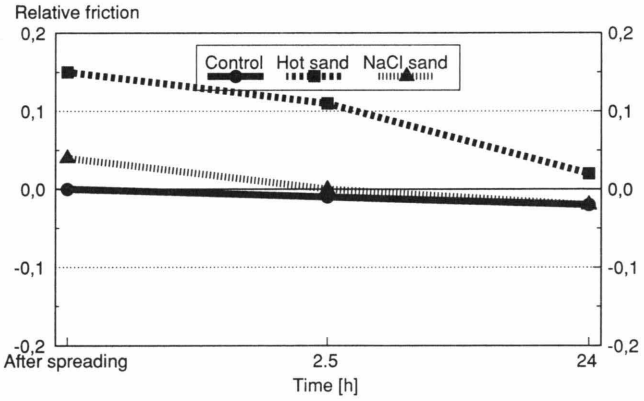

FIGURE 24 Curves of changes in friction values in best case.