New European Views on Snow and Ice Control Development

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In Europe developments in the winter maintenance field seen to be similar to those in U.S.A. and economic aspects still ask attention. Decreasing spreading rates, use of slush ploughs, and anti-skid bituminous surfaces that prevent or retard black ice formation are mentioned. Large field trials in spreading $CaCl_2$ solution instead of solid NaCl or $CaCl_2$ are reported as is some progress in black ice prediction.

Introduction

The information presented in this paper became available from cooperation in the PIARC Technical Committee on Operational and Winter Maintenance.

In order to obtain a good understanding, PIARC (Permanent International Association of Road Congresses)* has its main task in organizing a World Road Congress every four years and it enables a number of Technical Committees to operate. PIARC has about 60 member countries. The Technical Committee on Operational and Winter Maintenance was founded in 1965 in order to exchange information on winter maintenance. One of the main tasks of the Committee is to present a state-of-the-art report every four years to the World Road Congress. The Committee supports International Winter Maintenance Congresses in Europe at two-year intervals. This is one of the modes to fulfill the task of exchange of information. For this reason the Committee appreciates the liaison with the TRB Committee on Winter Maintenance and taking part in this symposium.

Most of the recent information on Committee activities and findings is to be found in reports to the Prague (1) and the Mexico City (2) World Road Congresses. The Proceedings of the International Winter Maintenance Congresses in Vienna (3) and Dobiacco (4) contain valuable information on European experiences. Since 1976 the scope of the Committee has been widened to the whole field of maintenance, as the name indicates, but still winter maintenance takes an important place in discussions between about 18 nations represented in the Committee.

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General Tendencies

In comparing developments in winter maintenance research and field experience in both the U.S.A. and Europe, my conclusion is that no large differences exist. The same topics of environmental aspects, energy conservation, mechanization of equipment, and social and economic aspects are to be found. However, the U.S.A. has had recent winters with heavy snow storms, whereas in Europe a number of recent winters have been relatively mild. This influences public opinion, motivation and training of personnel, and cost figures. Under the following headings some more detailed information on a number of items is given.

Environmental Aspects

From studies (2) in a number of European countries, it appears that under normal conditions damage to the environment by de-icing salt gives no cause for alarm. Simple measures can be taken to prevent damage at places where there could be danger. It is important to know that in many cases the interest of the ecologist and the economic interest of the road authority are parallel.

It is recommended that the use of de-icing chemicals be limited as far as possible. For this purpose the following twelve proposals are considered:

Winter Maintenance Without Salt

Winter maintenance without salt has been investigated as an alternative in Finland and Switzerland. In Finland it was concluded that no salt resulted in a lower standard of road condition, increased slipperiness and lower vehicle speeds. The use of salt did not seem to have any effect on the overall number of road accidents, but there were less severe accidents on roads where no salt was used.

In Switzerland in the winter 1972/73, slipperiness was fought on two road sections with only abrasive materials that increase skidding resistance.

The conclusions in comparison with previous years were:

1) On the road sections no serious accidents took place.
2) The number of accidents did not increase.
3) No appreciable changes of plants or animals in the surroundings have been reported.

The cost of winter maintenance without de-icing agents within the test period appeared to be more than three times as high as the cost of winter maintenance with salt spreading.

From the experiments and the observations of many road authorities it was concluded that melting agents have to be used for winter maintenance for reasons of road safety and economy.

Spreading Amounts

Owing to the climatic differences between the various countries a uniform recommendation for all cannot be made. As a minimum, 10 g/m^2 is recommended

Scandinavian countries sometimes use 6 g/m^2. In nearly all countries a normal use of 10 to 20 g/m^2, with a maximum of 40 g/m^2 for heavy snowfall, is advised.

Personnel

Personnel should be made more aware of the environmental effects of salt in order to avoid superfluous spreading. It is therefore necessary that they be well instructed and informed. The choice of equipment for winter maintenance and the determination of the right moment for action have a great influence upon salt consumption.

Spreading Equipment

Effective limitation of consumption requires that equipment be constructed in such a way that a prefixed amount of spreading material per square metre cannot be exceeded, independently of road speed and spreading width.

In Italy and France tests with special spreading equipment have been carried out with a solution of calcium chloride. From these tests it appears that the consumption of de-icing agents can be limited to 5 g/m^2. Spreading of this solution appears to be suitable for the prevention of black-ice slipperiness.

In the German Democratic Republic, winter maintenance is carried out by the spreading of a solution of magnesium chloride, as this is a mining waste product.

Snow Clearing

Large quantities of de-icing material can be saved by clearing snow with ploughs instead of melting by means of salt only.

Snow melting requires considerable amounts of salt. For slush clearing, special ploughs have been constructed with which the road can be swept practically dry.

In the interest of the environment and in order to prevent plants from being mechanically damaged, snowblowers on rural roads should not throw too far into the bordering ground.

Storage Yards

In the late 1950's and early 1960's when salt began to be used in increasing quantities for winter maintenance purposes there were a number of instances of fatal salt damage to both trees and plants in the vicinity of open stock piles. Having the modern covered salt stores and impermeable foundations with drainage away from vegetation, complaints have been reduced to a few isolated instances and cannot be considered a problem at the present time.

Figure 1. Covered salt store (the Netherlands).

Highway Design and Maintenance

Salt spreading should be taken into account when designing a road. If there is a risk of contaminating wells or ground water, adequate provision must be made for ditches or drains to remove water from the road to surface waters that are least susceptible to pollution. When designing highways, it should be borne in mind that maintenance centres constitute an integral part of the road and that they must include covered salt stores.

For roadside vegetation, species must be chosen that are salt resistant. In the report by three countries, 19 species are recommended and 17 are not recommended.

Ice-warning Systems

Ideally ice-warning systems may make it possible not only to give an early alert to personnel of the incidence of black-ice, but also to determine the right moment for action, preventative if possible, and the right doses.

The existing ice-warning systems are still in an experimental stage and are therefore not yet fit for the purpose. Investigations into ice-warning systems continue.

Organization

Good management of the winter maintenance service in which everyone's task is well-defined also assists in reducing salt consumption. One

item in this connection is the careful pre-planning of spreading routes to be followed by the spreading lorries. This is of great importance for motorways with complicated multilevel junctions.

Road heating

This method of winter maintenance is least detrimental to the surroundings of the road, but looked at more broadly, it adds to the environmental problems associated with the generation of electricity, such as cooling water problems. For economic reasons, however, road heating is not generally applicable since it is much too expensive and we will have to economize in energy consumption. For this reason road heating is not expected to play a significant part in winter maintenance. Application will be restricted to the beginning and the end of tunnels, bridges and other road sections, where no other means of winter maintenance can be used.

Drivers' attitudes and information

Drivers have come to expect winter traffic conditions to be identical to those in summer. This increases the responsibility of the winter maintenance service and very often gives rise to difficult situations, since changing winter conditions do not always allow complete removal of snow and black-ice in good time.

In many cases economic aspects are the determining factors. However, a first requirement must always be for the winter maintenance service to give the latest information to road users about the actual conditions on the road. Not only traffic safety but also economic interests require the unharmed traffic progress permitted by a high standard of winter maintenance. This is emphasized by the increasing tendency to prohibit the use of studded tyres, as in the Federal Republic of Germany and the Netherlands, or to restrict their use, as in many other European countries.

As a result an even greater responsibility rests with those in charge of winter maintenance. This means that close co-operation between the different highway authorities ranging from motorways to rural roads is necessary.

General

Improving the techniques and organization of winter maintenance is a continuing process parallel to that of traffic development and will continue to be so. More investigations on the influences of winter maintenance on the environment need to be carried out in order to give better founded recommendations.

Winter Maintenance Equipment

Winter maintenance equipment is no longer subject to large modifications or new findings. Automatic salt spreaders, with a constant rate of spread independent of the vehicle speed, are used more frequently. Rates of spread lower than 10 g/m^2 ask for careful calibration and periodical testing of equipment. The positive experience in using low spreading rates resulted in field experiments in Italy (5), France and Belgium with spreading $CaCl_2$ in solution.

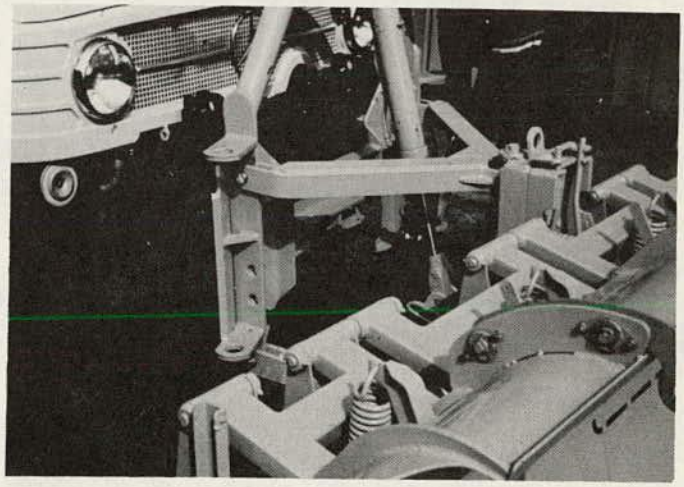
When using liquids, more accurate spreading rates are possible; other advantages, like easy loading, should be evaluated in relation to the financial aspect of the use of liquids. The trials at a number of maintenance stations in France and Italy that are fully equipped with special trucks and tanks for spreading solutions are encouraging.

Construction development of snow cutters and rotary blowers has led to a reliable series of machines that show modification for safety reasons and also for universal use in summer maintenance (see Fig. 2).

Figure 2. Summer use of winter maintenance trucks.

Snow blades have been made more efficient over the last years, and automatic mounting is more common (see Fig. 3).

Figure 3. Standardized plow hitch to decrease preparation time of equipment and stimulate multi-purpose use.



Attention should be paid to the slush plough. The special rubber blade (Fig. 4) enables it to remove slush with speeds up to 60 km/h. Continuous ploughing during snowfall might result in black pavements, if the snow storm is moderate. Removing slush is important in order to increase skid resistance, as slush is very slippery.

Figure 4a. Special plow for slush removal.

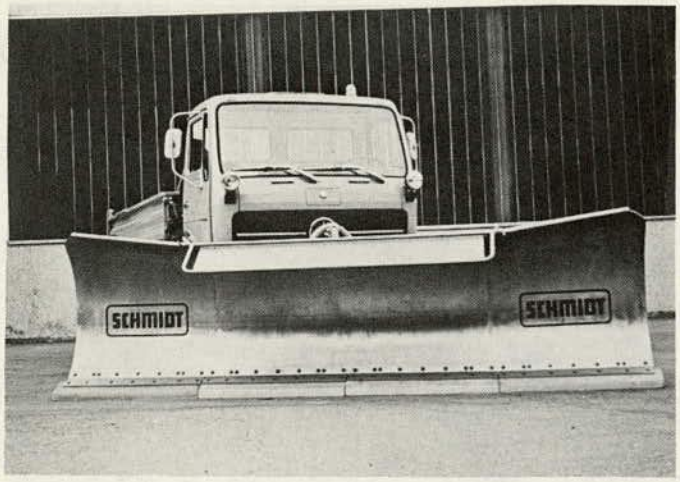


Figure 4b.

Anti-skid Bituminous Surfaces

Since 1974 experiments have been made with bituminous mixes containing 4-6% of a special agent, for instance, "Verglimit." Due to wear of tyres the special agent, primarily consisting of $CaCl_2$, is present on the road surface and will prevent or retard black ice formation. Field trials both on normal road stretches and bridges are carried out in Switzerland, Austria, Germany and France. Significant differences in performance have been found, compared with normal pavements. It took longer for black ice to form and the adhesion of snow to the road surface was lessened; accident figures are not yet available, however. In one field trial the cost per m^2 for a bituminous layer was 11 DM/m^2 for normal asphalt. This leads to the conclusion that the economic prospect for Verglimit, which also depends on its yet unknown durability, is not such that general application would be possible. However, if field trials remain positive, the anti-skid surfaces would compensate for preferential icing of bridges and other dangerous spots during black-ice formation. Special attention should be paid to skid resistance properties in the summer especially when formation of calcium chloride-hydrate is possible.

Economic Considerations

This will not be the last discussion on economic evaluation of winter maintenance. Due to differences in cost recording in the member countries it is hardly possible to compare and evaluate cost figures. Ahlbrecht (4) proves from results on 332 km of motorways in Germany that accident costs would have been 4 to 6 times as high as actual winter maintenance costs if no winter maintenance had been carried out. Monot and Bachelard calculated for the French national road network that salt, personnel and capital investments in buildings, equipment and radio systems are the most important cost elements. Figures of fixed and variable costs are, in this respect, meaningless because the severity of the winter might change the whole figure. Hammond showed a decision-making model to examine the economic justification of winter maintenance. Further experience with this model should be gained. It seems that economic justification of winter maintenance on motorways is not difficult. More difficult, however, is to establish the level of service in winter of other road categories with less traffic and comparable maintenance costs.

Prediction of Black-ice Formation

More experiences have been gained with ice-alert systems. Austria now has a leading position in this respect with 80 ice warning installations and 140 snow warning apparatuses in use, most of them of the "Boschung" type. Rosema and Welleman (6) investigated factors influencing black-ice formation. A model to predict road surface temperatures has been built. Field trials, such as spot measurements and infrared line scanning from an aeroplane, indicated that this model was suitable.

Photos showing the thermal image of road sections and adjacent areas stress the influence of sunshine at daytime and the heat flow in the road. In case of the absence of this heat flow, as on bridges, considerable differences may be found.

Differences on normal pavements from 267 K to 271.6 K were found. This type of investigation would lead to more insight into dangerous spots and places to locate ice warning equipment. Generally a model is necessary to predict black-ice formation.

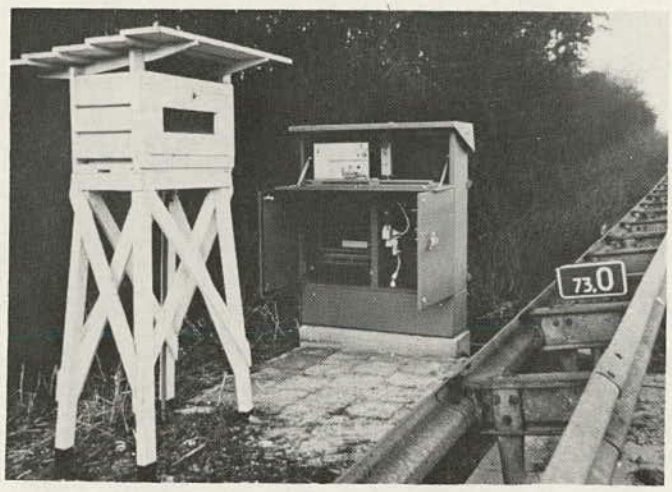
Ten Cate (4) reported that current results of the 't Harde ice warning project indicated that saltings may be reduced by 10 or 20% and salting actions could prevent black-ice formation. The system used consisted of 10 measuring spots (Fig. 5) in which road temperature, road conductivity, air temperature and air humidity could be measured and processed by a central minicomputer.

In these systems man-machine interactions are of significant meaning for the success of this type of equipment. Cost estimates are difficult to judge as social and environment aspects are hard to evaluate.

Conclusion

In winter maintenance, laboratory investigations and field experience both contribute to progress. Economic and environmental aspects receive more attention than pure technical developments. Exchange of research is a fruitful approach in this very special area.

Figure 5. Sensors and transmitting equipment at 't Harde ice warning project.



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