EVALUATION OF LIQUID ICE CONTROL CHEMICALS APPLIED TO BRIDGE DECKS
(Progress Report)

MICHIGAN DEPARTMENT OF STATE HIGHWAYS

EVALUATION OF LIQUID ICE CONTROL CHEMICALS APPLIED TO BRIDGE DECKS
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J. H. DeFoe

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E. V. Erickson, Chairman, Charles H. Hewitt,
Vice-Chairman, Carl V. Pellonpaa, Peter B. Fletcher
John P. Woodford, Director
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Prompt removal of ice and snow and the prevention of ice formation on highway surfaces is a vital aspect of highway maintenance. In order to accomplish this task, ice melting chemicals are applied in conjunction with scraping and plowing operations. Calcium chloride and sodium chloride, which are relatively inexpensive and readily available, are most often used for this purpose. These chlorides, however, are corrosive and accelerate deterioration of steel and concrete used in highway structures. Damage to bridges is of special concern because repairs are costly, hazardous, inconvenient to the motorist, and must be made quickly before further serious structural damage takes place.

To alleviate this situation, the Research Laboratory began a research project in August, 1972 to evaluate the ice melting effectiveness of four liquid solutions submitted by different suppliers: Kaiser Agricultural Chemicals (ISOLV); Dow Chemical (XF-4090L); Union Carbide (UCAR); and Allied Chemical (ARD-45), which were claimed to be non-corrosive to structural materials. Shortly after the start of this project, the Allied product (ARD-45) was removed from the market and was not included in this study.

All of the materials supplied are basically glycol solutions of which some contained a dissolved urea compound. Each liquid, according to the supplier's literature, is effective at rates varying from 1 gal/500 sq ft to 1 gal/2,000 sq ft, depending upon storm and temperature conditions at the time of application. Prices of the solutions were about $1.00/gal, in 1973.

Some of these, or similar chemicals, have been in use for several years at major airports to remove ice from aircraft and, to some extent, from paved runway surfaces. Highway application is more recent and has been on an experimental basis, primarily on bridge decks. In spite of assurances by suppliers that the liquids are not harmful to the environment, a recent study[1] shows these chemicals to "have an extremely high biochemical oxygen demand (BOD); one analysis indicated a BOD of 430,000 mg/l."

Initial laboratory studies and limited field measurements of the chemical's effectiveness were conducted during the winter of 1972-73. Results of these preliminary tests were reported in July 1973 along with recommendations for in-service evaluation on selected bridges during the 1973-74 winter season[2]. Results of this latter in-service evaluation are presented in this report.

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[1] "Effect of Aircraft Deicer on Airport Storm Runoff," Journal, Water Pollution Control Federation, V. 46, Jan. 1974, M. Schulz and L. J. Comerton.

[2] "Evaluation of Liquid Chemicals for Preventing Ice Formation on Highway Bridge Decks," (Progress Report), Michigan Department of State Highways and Transportation, Research Report No. R-870, July 1973, J. H. DeFoe.

In-Service Evaluations

Field evaluation tests were initiated at the Blue Water and Mackinac bridges in December 1973. Applications of the liquid chemicals were made with spray equipment normally used for roadside weed control but modified for this project. As originally proposed, the chemicals were to be evaluated as both anti-icing and deicing agents. As anti-icers the chemicals were applied routinely twice each week and whenever a storm seemed imminent. For deicing pruposes the liquids were applied shortly after a storm began and their effectiveness determined in melting existing ice, aiding mechanical removal of snow or ice accumulation, and for preventing further accumulations of ice or packed snow.

Test Conditions

Applications were generally made at temperatures ranging from 20 F to 34 F, with deicer application temperatures averaging 28 F. Precipitation involved freezing rains and wet blowing snow with deicing applications made after some ice accumulation had occurred (usually 1/4 in. or less). The chemicals were applied at the rate of 1 gal/1,000 sq ft for both anti-icing and deicing evaluation.

Results

A total of 23 test applications were reported. Three of these were conducted at the Mackinac Bridge prior to equipment breakdown which could not be corrected in time for further testing. Twenty applications were made at the Blue Water Bridge the results of which are summarized in Table 1. Of the 20, 12 were made as deicing measures and of these, only one application was judged to be ineffective. As anti-icing agents, however, only one of eight applications were rated as effective with four rated not effective.

TABLE 1
Effectiveness of Ice Control Liquids

	Number of Applications as:	
	Deicer	Anti-icer
Effective	11	1
Not Effective	1	4
Inconclusive	0	3
Total Number of Applications	12	8
Percent of Applications Effective	91.5	12.5

After several applications as anti-icing agents it became apparent that the weekly applications were of little value so they were discontinued in

favor of concentrating all efforts on the time of actual storm conditions. Operations conducted in this manner resulted in certain applications which might be considered as either preventive or ice removal measures. In the data represented by Table 1 such applications were considered as removal or deicing applications because the chemical was applied over some small amount of initial ice or packed snow accumulation even though beneficial results in preventing further accumulation were obtained. Under a continued high rate of snowfall, however, blading and sanding also were necessary to achieve safe traffic conditions.

Conclusions and Recommendations

Based on this field evaluation of winter 1973-74 the following conclusions are made.

1. The chemicals were effective in removing ice or packed snow when applied during initial storm conditions while ice accumulation is 1/4 in. or less.

2. The chemicals are not effective in preventing ice or snow accumulation when applied as preventive measures in advance of storm conditions.

3. Continued heavy snowfall requires blading and sanding to achieve safe driving conditions.

It is recommended that further use of these chemicals be limited to situations where applications can be made at the time of incipient freezing so that, with the help to traffic abrasion, slippery conditions are prevented. Furthermore, scrapers, sand or conventional chlorides must be immediately available to prevent dangerous conditions from developing as the result of a prolonged or heavy snowfall.

The potential of certain other chemicals such as tetra-potassium pyrophosphate (TKPP) or a urea-calcium formate mixture as substitutes for chlorides should also be considered. The following list of references describes recent research into the more promising chemicals.

References Concerning Alternate Ice Control Chemicals

1. "A Summary of Various Materials Used for Winter Maintenance Ice Control," Michigan Department of State Highways and Transportation, J. H. DeFoe memo to R. C. Mainfort, October 22, 1973.

2. "Economical and Effective Deicing Agents for Use on Highway Structures," Highway Research Board, NCHRP Report No. 19, 1965.

3. Forbes, C. E., et al, "Snow and Ice Control in California," Highway Research Board Special Report No. 115, 1970.

4. "Deicing Chemicals Avoid Bridge Deterioration," Better Roads, July 1974.