Snow and Ice Control with Chemical Mixtures And Abrasives

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•THE EFFECTIVENESS in snow and ice control of mixtures of calcium chloride and rock salt, with and without abrasives, was tested during the winter of 1958-59 by the New York State Thruway Authority, in conjunction with the Calcium Chloride Institute. Results of this 1-yr test program (1) were promising enough to justify a second 1-yr study the following winter. The second study emphasized the refinement of application to achieve the most economical use of chemical mixtures.

This paper reviews the 2-yr test program and reports on experience over the succeeding 3-yr period. An outline of winter conditions, analysis of the economic benefits to be derived from use of chemical mixtures, and general observations and recommendations for snow and ice control procedures are included.

1958-59 TEST

The original test area, the Weedsport Maintenance Section, is located in Central New York State. The Syracuse Maintenance Section to the east and Manchester Maintenance Section to the west were used as control sections. On the Weedsport section a mixture of 1 part regular flake calcium chloride (type 1) to 2 parts salt (1: 2) by volume was used either exclusively or with abrasives under all storm conditions. Straight salt alone or with abrasives was used on the control sections. Performance was observed and recorded on report forms after each storm.

By the end of the first year test program, it was clear that the use of calcium chloride in mixtures with rock salt provided faster and more effective melting action than salt alone.

1959-60 TEST

The primary modifications in the second study were (a) use of straight salt at temperatures near 30 F where salt has proven to be effective, and (b) more emphasis on the use of a chemical mixture with abrasives (salt, calcium chloride and abrasives proportioned 2: 1: 3 by volume). The Weedsport Maintenance Section was again used as the test area. The Manchester Section was the only control section due to equipment shifting problems in the Syracuse Section. As in 1958-59, total inches of snowfall continued well above average, and number of days with measurable snow was about the same as the previous year. Temperatures averaged about 3 F higher than during the previous winter.

This test confirmed the findings of the 1958-59 test that calcium chloride greatly speeds up the slower melting action of rock salt, particularly at temperatures of 25 F and lower. The standard 2: 1 chemical mixture, combined with an equal quantity of abrasives, was found to be economical and effective. Premixing of chemicals and bulk storage posed no problem.

The problem of starting motors was decreased by washing equipment after storms with hot water and spraying wires and spark plugs with a silicone lubricant preservative "4X Spray" made by Dow-Corning Corporation.

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The use of salt in the 30 F range, and chemical mixtures with or without abrasives at lower temperatures and during ice and sleet storms, resulted in an indicated saving of $4,540 on the test section over the control section. The computation method is given in the report of results of first 1-yr test program (1, p. 5).

As shown in Table 1, actual use of calcium chloride decreased by 252 tons or 33 percent from the previous winter. Salt use showed an increase.

TABLE 1

USE OF SALT AND CALCIUM CHLORIDE FOR WINTER MAINTENANCE OF THRUWAY

Section	Chemical (tons)					
	1957-58		1958-59		1959-60	
	Salt	$CaCl_2$	Salt	$CaCl_2$	Salt	$CaCl_2$
Weedsport[a]	3,590	0	3,040	770	3,420	518
Weedsport[b]	-	-	4,340	0	4,757	0
Syracuse[a]	2,610	0	3,230	0	-	-
Manchester[a]	2,350	0	3,230	0	3,540	0

[a]Actual. [b]Theoretical.

1960-63 EXPERIENCE

Based on the excellent results during the test program, and on economic studies which indicated the possibility of an actual saving or at least no cost increase over the policy of relying on straight rock salt alone, calcium chloride-salt mixtures were incorporated into the Thruway's winter maintenance program. During 1960-61, the 559-mi Thruway began following procedures used in the Weedsport Section during the second year.

Weather Conditions

The 3-yr use of mixtures over the entire length of the Thruway System involved a greater variety of winter conditions than found in the test section. The northeast coastal influence is felt in the New York City area. The western end of the Thruway experiences Central States weather, modified somewhat by the local influence of the

TABLE 2

WEATHER CONDITIONS VS CHEMICAL USAGE ALONG THRUWAY ROUTE

Location	Dec.-March Avg. Temp. (°F)	Total Days of Snow ≥ 0.1 in.	Total Snowfall (in.)	Salt Used (tons)	$CaCl_2$ Used (tons)
		(a) 1958-59			
New York City	33.5	7	18.1	5,100	--
Albany	23.3	20	63.2	9,500	--
Syracuse	23.3	68	137.2	15,490	770
Buffalo	25.0	65	114.5	20,200	--
Total				50,290	770[a]
		(b) 1959-60			
New York City	36.3	12	33.5	5,900	--
Albany	26.7	13	60.1	10,100	--
Syracuse	27.0	72	134.9	16,030	517
Buffalo	27.5	65	115.6	21,900	--
Total				53,930	517[a]
		(c) 1960-61			
New York City	34.3	14	56.5	5,768	250
Albany	23.8	13	72.7	6,342	290
Syracuse	25.6	71	128.5	9,515	448
Buffalo	23.8	64	89.4	15,300	700
Total				36,945	1,688
		(d) 1961-62			
New York City	35.0	14	16.0	6,925	136
Albany	26.4	15	62.6	10,921	376
Syracuse	27.0	54	77.3	12,342	395
Buffalo	26.6	69	101.4	14,712	432
Total				44,800	1,339
		(e) 1962-63			
New York City	32.6	18	16.8	9,060	210
Albany	23.7	38	71.3	13,840	535
Syracuse	24.6	73	113.0	16,280	535
Buffalo	24.7	72	89.7	21,180	523
Total				60,360	1,803

[a]Weedsport only.

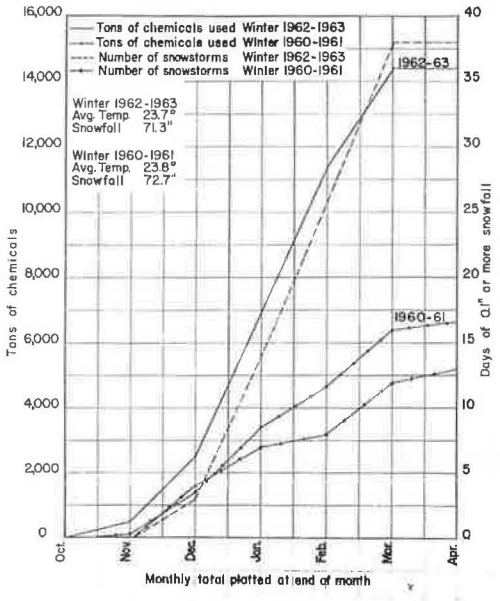

Figure 1. Chemical use vs days of snowfall.

Great Lakes. Average snowfall varies from 120 to only 31 in./yr. Table 2 compares weather conditions and chemical use on the Thruway for the 5 yr under consideration. Figure 1 shows the close correlation between total days of snowfall and tons of chemicals used during the winters of 1960-61 and 1962-63, even though total snowfall and average temperature were about the same.

Factors Influencing Calcium Chloride Use

The three winters that calcium chloride-salt mixtures have been used on the entire Thruway have been cold and dry. Maintenance crews in other than the Weedsport Section have had little chance to develop experience in the new procedures. As a result, total calcium chloride use in the 1962-63 winter was only 1,803 tons compared with 60,363 tons of salt.

Restrictions to control calcium chloride use, imposed when the mixture program was adopted, have contributed to its low use. The maintenance directive, issued in October 1960, cautioned that calcium chloride tonnage could not exceed 15 percent of salt tonnage. It also prohibited the use of calcium chloride except from December 15 through February. A final caution was that no calcium chloride be used without the consent of the section supervisor, and that none be used between the hours of 2100 and 0500. It was soon evident that these restrictions were not needed, and they are not included in the present maintenance directive. They did, however, adversely affect the total figures for use of calcium chloride and salt on the Thruway. The mixture use on the Weedsport Section (Table 3) gives an indication of the anticipated use on the entire Thruway as other personnel gain experience.

ECONOMIC BENEFITS

The normal chemical mixture, used either directly or with abrasives, contains 1 part calcium chloride to 2 parts salt by volume. This is approximately a 1:3 proportion on a weight basis due to the lighter weight per cubic foot of calcium chloride. The average cost of the normal mixture during the past winter was about $16.50 per ton or about $5.60 per ton more than the average cost of salt. The cost of the mixture when applied with an equal amount of abrasive was $9.50, or $1.40 less per ton than salt.

Savings indicated by the 1959-60 Weedsport tests compare favorably with cost studies conducted in Connecticut in 1961-62. The proportion of calcium chloride to salt used over the 5-yr period on the Weedsport Section is similar to routine use of chemical mixtures on the Ohio Turnpike.

In Connecticut, chemical mixtures and a minimum of abrasives were used at all temperatures on several test sections totaling 169 mi. Weather conditions and procedures were similar on

TABLE 3

CHEMICAL USE ON WEEDSPORT MAINTENANCE SECTION

Period	Salt (tons)	$CaCl_2$ (tons)
1958-59	3,040	770
1959-60	3,420	517
1960-61	1,222	110
1961-62	2,459	136
1962-63	3,770	223
Total	13,911	1,756
Percent	89	11

all sections. Straight salt and the normal amount of abrasives were used on control sections of 156 mi. At the end of the 1-yr test, total ice removal costs for the test sections were $131 per mile less than for the control sections. This savings reflected reduced materials costs, equipment use, man-hours and spring clean-up.

Cost studies on the Weedsport Section of the New York Thruway during the 1959-60 winter indicated an estimated saving of $71 per 2-lane mi for chemicals alone. Added savings from reduced equipment time and man-hours would undoubtedly bring the Weedsport savings to a figure at least equivalent to the Connecticut savings of $131 per mile.

STORAGE AND HANDLING PROCEDURES

Since the beginning of the test program, all calcium chloride and salt has been delivered in bulk by truck directly to the storage locations. At the Weedsport Section, the bulk calcium chloride was stored in a frame structure added to one side of the existing salt shed. A canvas rigged over the front of this shed was found to be inadequate and was later replaced with an overhead door. This provided satisfactory winter storage, but the calcium chloride did attract moisture from the air during summer months. This problem will be solved by placing a moistureproof cover tightly over the calcium chloride during the summer.

The three-sided, roofed salt storage sheds, which have been in use since the Thruway opened, have been modified by placing a divider from front to rear. Calcium chloride and/or premixed calcium chloride and salt is stored in one side with a 6-in. sand cover. Dry rock salt is stored in the other side for use in preparing mixtures or loading directly into spreaders. Minimum quantities usually stored at each maintenance section during winter months are 200 tons of rock salt and 80 tons of calcium chloride-salt mixtures.

Premixing the calcium chloride and salt is accomplished with a front-end loader or with a belt conveyor rigged with two hoppers. Calcium chloride is loaded into one hopper, salt into the other, and gates on each hopper are adjusted to obtain the desired mixture.

GENERAL OBSERVATIONS

A number of general observations have been made during and as a result of the 2-yr test program on the Weedsport Section and the addition of calcium chloride-salt mixtures to the regular winter maintenance program of the entire Thruway. The following list summarizes the benefits from and limitations to the use of calcium chloride with salt for snow and ice control:

1. Calcium chloride acts as a triggering agent and greatly speeds up the slower melting action of rock salt. Performance of chemical mixtures is superior to that of straight salt, particularly at temperatures below 30 F.
2. The use of chemical mixtures is extremely valuable during clean-up of the pavement after a storm.
3. With the faster melting action, bare pavements are obtained faster, resulting in considerable savings through prevention of accidents and slideoffs.
4. The addition of calcium chloride to rock salt reduces loss of salt due to throw off and bounce during and immediately after spreading.
5. The use of the standard chemical mixture with abrasives results in more effective use of abrasives than had been obtained with straight salt.
6. Storage of bulk calcium chloride and mixtures has not been difficult when reasonable care is exercised to protect the material from moisture.
7. Premixing of calcium chloride and salt between storms is the most practical method of obtaining a uniform mix on the road.
8. A satisfactory mixture for storm conditions, other than those controlled with straight salt, is made up of 1 part calcium chloride and 2 parts salt by volume. This is used alone or with abrasives. For hard-packed snow and heavy ice, a 1:1 mix is sometimes used.

9. Mixing of the two chemicals involves some extra handling estimated to cost $1.25 for each ton of calcium chloride used.

10. Mixing of calcium chloride with wet salt or during rainy weather can cause severe caking. Salt with less than 2 percent moisture can be considered dry.

11. Spreaders cannot be kept loaded with a mixture in a warm garage because of caking.

12. A mixture of half chemicals and half abrasives is economical and effective but cannot be premixed.

13. No major difficulty in engine performance has been encountered since the first year of testing. All spreaders have been converted to hydraulic operation to eliminate the gasoline-powered motors. All machinery is washed after each use.

14. A reasonable proportion of calcium chloride to salt improves performance and does not increase the total cost. In fact, the use of 15 percent calcium chloride on the Weedsport Section during the 1959-60 winter resulted in a saving when compared with the control section.

15. Budget control over the more expensive calcium chloride has proved to be no more difficult than over other materials. The degree of supervision normally exercised by maintenance organizations in the application of rock salt and abrasives should be adequate for a program including calcium chloride-salt mixtures.

REFERENCE

1. Lang, C. H., and Dickinson, W. E., "Chemical Mixture Test Program in Snow and Ice Control." HRB Bull. 252, pp. 1-8 (1960).