Midwest Use of Rock Salt for Snow and Ice Removal

A. F. Haelig and C. R. Harte, Salt Institute, Chicago, Illinois

ABSTRACT

A survey involving 52 interviews with toll road, state highway, city and county people inquired as to current practices in the use of rock salt for snow and ice removal from streets and highways. Scope of this investigation covered 145,000 miles of two-lane roadway for which the 1963-64 tonnages of snow and ice control materials used were: rock salt -- 1,200,000; calcium chloride -- 60,000; and abrasives -- 2,000,000.

Practices in use of rock salt for winter highway maintenance vary widely. Toll roads are the heaviest users, calling for about 50 tons of salt per two-lane mile, per season. Counties use only a few tons, or none at all, while cities and state highway systems frequently use about ten tons per two-lane mile, per season.

Weather conditions affect the use of rock salt markedly. Cities having an average annual snowfall of 80 inches were found to use about twice as much winter street-maintenance salt as cities having only about 30 inches of annual snowfall.

Application rates for salt vary widely. Many cities and counties lacked data and where information was available spreading rates all the way from 200 to 2,500 pounds per two-lane mile were reported. State highway and toll road systems have good records on application rates and most of these authorities apply salt at a rate of about 500 pounds per two-lane mile.

There is a wide range of practice; with respect to the equipment used for spreading salt and as to facilities provided for salt storage.

INTRODUCTION

This section, Section 2, of your Salt Symposium is entitled 'Mining," but I'm not going to talk about mining salt. Instead, I'm going to talk about how a lot of the mined rock salt is used for street and highway snow and ice control. Figure 1 shows how much salt has been used this way in recent years. Usage has increased markedly from 800,000 tons in 1950 to four million tons in 1964 and there are those who predict ten million tons within a few years. At the present level snow and ice control consumes close to half of all the rock salt mined in this country.

What I'll have to say is based on a study of midwest practices in the use of rock salt for snow and ice control made recently for the Salt Institute by Mr. Arthur Haelig and myself. Pertinent information was obtained by calling at maintenance offices and interviewing officials in charge of snow and ice control programs.

Relatively complete information was obtained for 20 counties, 17 cities, 7 state highway departments, and 4 toll roads, principally in Illinois, Indiana, and Michigan. In the interviews, questions were asked as to: mileage of streets or highways serviced; quantities of snow and ice control materials used; weather conditions encountered; practices as to timing and rate of application; how practices are modified to meet different temperature conditions; spreading equipment used, and availability of storage facilities.

Information as to practices was obtained covering approximately 145,000 miles of equivalent two-lane roadway for which winter maintenance rock salt for the 1963-64 winter was 1,200,000 tons, or approximately 25% of the total U.S. salt usage for this purpose. It was found that the different types of control authorities, counties, cities, state highway departments, and toll roads employ different practices. This is shown in Fig. 2. It will be noted that the 20 counties used 27,000 tons of rock salt and an approximately equal amount of abrasives. The 17 cities, for many of which salt was the only snow and ice control material used, reported 95 thousand tons of salt and only 15 thousand tons of abrasives. The state highway departments with their thousands of miles of highway to service reported they used a million tons of salt, two million tons of abrasives, and 56 thousand tons of calcium chloride. The toll road systems, like the cities, generally preferred essentially straight salt and the figures here show they used 58 thousand tons of salt with only four thousand tons of abrasives. The total survey as indicated contacted the users of about a million tons of salt and about two million tons of abrasives. The last line shows the relative quantities of the materials used based on 100 of salt. These relative quantities are 174 of abrasives and 5 of calcium per 100 of salt.

ROCK SALT FOR HIGHWAY USE

YEAR	TONS USED
1950	800,000
1955	1,300,000
1960	2,400,000
1962	3,200,000
1964	4,000,000

Figure 1

S&I MATLS USED (M TONS)

	SALT	CAL	ABR
20 COUNTIES	27	1	33
17 CITIES	95	1	15
7 ST HY DPTS	1,000	56	2,000
4 TOLL ROADS	58	2	4
TOTAL SURVEY	1,180	60	2,052
PER 100 SALT	100	5	174

Figure 2

Relative usage factors for different classes of roadway maintenance authorities are shown in Fig. 3. Here again we see that large cities and toll roads use essentially straight salt. The large cities reporting only 2 abrasives and less than 1 calcium per 100 of salt and the toll roads have a somewhat similar relationship, with 7 abrasives and 3 calcium per 100 salt. Big-city counties and the smaller cities use substantial amounts of abrasives. The big-city counties reported about as much abrasives as salt with relative numbers of 97 and 100, while the smaller cities used about half as much abrasives as salt, the numbers here being 54 and 100. Counties other than big-city counties and state highway systems are heavy users of abrasives, the tonnage for this material running about twice that for salt as indicated by relative numbers of 205 and 100 for these counties and 200 and 100 for the state highway departments. There would seem to be an opportunity for the salt industry to spread the gospel of the advantages of salt over abrasives with particular attention to the state highway departments, most counties, and the smaller cities. The advantage of salt over abrasives is particularly great in the cities on account of the problem of cleaning streets and clearing drainage systems after use of abrasives.

An attempt was made to find some logical basis for comparing the amount of snow and ice control salt used by different maintenance authorities. Two indices tried were tons per 1,000 of

population and tons per mile of two-lane roadway served. Results of this analysis are shown in Fig. 4. A relationship to population is pertinent only for counties and cities, and even here it is an indirect sort of thing, meaningful only through acceptance of the assumption that, for reasonably similar communities, a given population would be likely to have a certain definite amount of roadway to serve. For what they are worth, the figures developed for tons per 1,000 of population were 3 for the counties, and 16 for the cities. Going to tons per mile served we get a very wide range going all the way from 2 for the counties to 47 for the toll roads with the state highway departments for the cities in between with 8 and 13 respectively.

RELATIVE AMOUNTS OF MATERIALS USED

	SALT	CAL	ABR
Big-City Counties	100	1	97
Other Counties	100	9	205
Large Cities	100	<1	2
Smaller Cities	100	3	54
St. Hy. Depts.	100	6	200
Toll Roads	100	3	7

Figure 3

SALT USE 1963-64

	T/M POP	T/MI SERV
20 Counties	3	2
17 Cities	16	13
7 St. Hy. Depts.	--	8
4 Toll Roads	--	47

Figure 4

Obviously a most important factor influencing the amount of salt used for winter maintenance is the amount of snow and ice with which a particular community is afflicted. Some snowfall data are shown in Fig. 5. These data are from U.S. Weather Bureau statistics and are averages for the three years, 1961-63. Six cities in the survey territory are shown, including South Bend and Grand Rapids, which get about 80 inches of snow per year, Sioux City and Chicago with 45 inches and Springfield and Indianapolis with about 30 inches. The amount of salt required for winter maintenance will depend upon frequency of snowstorms as well as the total amount of snow per season. However, the statistics for the six cities of Fig. 5 indicate an essentially fixed relationship between the amount of snow and frequency. It seems that frequency is about 1/3 of the amount. Apparently, although snowstorms vary widely in inches per individual storm, the average depth per storm over a moderate period of time is nearly constant at about three inches.

At any rate, the thought occurs that one might use the population of a city as a measure of how much roadway will require winter maintenance and then use the expected snowfall as a measure of how much winter maintenance will be required; and, by putting the two factors into an equation, one might predict what would be a reasonable salt usage for that particular city. A test of this theory is shown in Fig. 6. Here we have our six cities and population, average snowfall and salt usage for each. Also, the figure shows a factor obtained by dividing the salt usage by the population and the snowfall. It is interesting to note that four of the six cities have a factor not very far from .4. It might be assumed that this represents a normal practice. This would lead to the tentative conclusion that South Bend with a factor of .1 uses abnormally little salt, whereas Sioux City with a factor of .7 is abnormal on the high side.

A question which has come in for a great deal of attention is that of: "What is the lowest temperature at which rock salt is reasonably effective in the practical operation of snow and ice control?" It is known from the physical chemical properties of sodium chloride and ice that the melting action goes down to -6°F. Some enthusiastic salt users express confidence that salt is effective at temperatures well below zero, and one could believe this, if one bears in mind that the earth and highway temperatures are frequently substantially higher than the temperature of the air above a road. On the other hand, promoters of competitive de-icing chemicals are fond of claiming that below 25°F salt alone is not adequately effective. Figure 7 tabulates the answers to

AV SNOWFALL DATA 1961-63

	AMT	FREQ	AV AMT
SOUTH BEND	80	26	3
GRAND RAPIDS	85	25	3
SIOUX CITY	45	14	3
CHICAGO	45	12	4
SPRINGFIELD	27	9	3
INDIANAPOLIS	29	11	3

Figure 5

SALT USE FACTORS FOR CITIES

CITY	POP	SNOW	SALT	FACTOR
SB	133	80	1,080	.10
GR	205	85	7,700	.44
SC	90	45	2,890	.71
CHI	3,550	45	50,000	.31
SPR	83	27	850	.38
IND	476	29	4,800	.35

Figure 6

the question of minimum temperature which were obtained from the people interviewed. There is certainly a wide difference of opinion as indicated by the fact that six replies said "all normal temperatures" and four people named temperatures below 10°, while six mentioned 25° or higher. The most popular answer was 10° with ten interviewees picking this number. It is gratifying to note that responses from 32 named temperatures ranging down from 20°, whereas only six lacked confidence below 25°.

Another area in which there was a wide difference of opinion related to the application rate which should be used for salt. A tabulation of the answers to a question on this point is shown on Fig. 8. A revelation from this inquiry was that the administrative offices of many maintenance

MINIMUM TEMP SALT EFFECTIVE

	ANT	<10	10	15	20	25	>25
Counties	3	2	3		2	1	1
Cities	1	2	6	1	3	2	
St Hy Dpts			1	2	3	1	
Toll Rds	2				1	1	
	6	4	10	3	9	5	1
			32			6	

Figure 7

SALT APPLICATION RATES

	<500	500-900	>900	J
Counties	1	3		11
Cities	1	3	3	10
St Hy Dpts	4	2		
Toll Rds	2	1		
	8	9	3	21

Figure 8

operations did not know what rate of application was applied. This answer is designated by "J" (for "judgment") in the figure, meaning that the foreman or truck driver spread the salt lightly or heavily as his judgment might dictate. For counties and cities more often than not the judgment policy is followed. Where the counties or cities did have definite information, a spread of from 500 to 900 pounds per two-lane mile was the most popular, although there were two reports of less than 500 and three reports of greater than 900. The state highway departments and toll roads usually have adopted application rates based on experimentation and thought on the part of their technical people. For these authorities six replies indicated less than 500, and three replies indicated 500 to 900 pounds per two-lane mile. Actually these are not so very far apart since "less than 500" was frequently a 400-pound spread and 500 to 900 may well be a 600-pound spread. Looking at the picture as a whole it would seem that about 600 pounds per two-lane mile would be

recommended by many authorities. Noting that three cities indicated application rates greater than 900 it is to be pointed out that congestion may make it difficult to get back for a second spread so that an intensive first spread may be the best procedure in certain city situations.

Spreading Equipment

A considerable amount of information was obtained as to the spreading equipment used by different maintenance groups. It was found that there is a wide field of choice insofar as equipment is concerned. Many different types and makes of spreaders are used, including tailgate models and various spinner types, but there does not seem to be any very positive indication that one type is outstandingly more effective than another.

Storage Facilities

Storage facilities included both inside and outside storage with and without the use of covers. Many authorities are using open, uncovered outside storage piles and find that salt so stored remains in good condition for a long time. Others feel that some weather protection is essential, in a building if possible, but at least under canvas or plastic covers if outside.