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EVALUATION OF IMPROVED CALCIUM MAGNESIUM ACETATE AS AN ICE CONTROL AGENT
Final Report

MICHIGAN DEPARTMENT OF TRANSPORTATION

MATERIALS and TECHNOLOGY DIVISION

EVALUATION OF IMPROVED CALCIUM MAGNESIUM ACETATE AS AN ICE CONTROL AGENT
Final Report

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ACKNOWLEDGEMENT

This project was successfully completed through the cooperative efforts of maintenance personnel in District 8. Special thanks are extended to the staff and especially equipment operators of the Charlotte Maintenance Garage for their dedication and commitment to the project.

ABSTRACT

This field trial was conducted to evaluate the effectiveness of the improved 'pelletized' formulation of calcium magnesium acetate (CMA) as well as that of the CMA-coated sand.

Applications of the two forms of CMA and conventional salt and salt-sand mixtures were made on adjacent and comparable sections of I 69 near Charlotte during winter storm conditions of the 1986-87 and 1987-88 seasons. The test sections were selected to be as nearly equivalent as possible with respect to traffic volumes and local topography.

Both forms of CMA were evaluated using application equipment and procedures normally used by MDOT for winter maintenance. Salt and salt-sand mixtures were also applied to adjacent sections of highway during the same storm activity to provide control data as a basis for comparison. Meteorological data and pavement conditions as well as material handling and spreading characteristics were recorded for each storm application.

Calcium magnesium acetate materials were compared with conventional rock salt and rock salt-sand applications during 17 winter storms. One hundred tons of CMA, 100 tons of sand coated with CMA, and 69 tons of rock salt were used in this evaluation.

Results of this two-winter field evaluation show that for typical southern Michigan conditions, CMA as an ice control agent is somewhat less effective than rock salt even when applied at over twice the rate at which salt is applied. The material cakes-on and plugs the equipment and makes cleanup very difficult.

The new pelletized form of CMA is a considerable improvement over the previously evaluated flake. The density of the CMA particles has been increased, dust is reduced, and more CMA can be hauled per load. Applicability was improved and penetration to the pavement was often noticed, a brine was not formed as readily as with salt.

Despite its shortcomings CMA could be a useful ice and snow control chemical when coupled with appropriate mechanical removal methods.

INTRODUCTION

This report describes the second field trial of calcium magnesium acetate (CMA) conducted by the Michigan Department of Transportation. Both trials were conducted as part of a pooled fund study administered by the Federal Highway Administration. The first field evaluation (Research Report No. R-1248) conducted during the 1983 and 1984 winter seasons used 98 tons of CMA applied during 22 winter storms. As a result of this study it was concluded that CMA could be effective for ice control and snow removal but required two to three tons of CMA to achieve the comparable degree of effectiveness of one ton of rock salt.

Subsequent to the earlier field trial, a stronger, non-dusting, granular form of CMA was developed having a reported melting rate of at least three times that of the 1983-84 CMA. A procedure for coating sand with CMA to provide both traction and ice melting was also developed to the point where the coated sand could also be included in this field trial. The purpose of this second field trial was to evaluate the effectiveness of the improved, pelletized formulation of CMA as well as that of the CMA-coated sand.

Applications of the two forms of CMA and conventional salt and sand mixtures were made on adjacent and comparable sections of I 69 near Charlotte during winter storm conditions of the 1986-87 and 1987-88 seasons. The test sections were selected to be as nearly equivalent as possible with respect to traffic volumes and local topography. Location of the test site is shown in Figure 1.

Both forms of CMA were evaluated using application equipment and procedures normally used by MDOT for winter maintenance. Salt and salt-sand mixtures were also applied to adjacent sections of highway during the same storm activity to provide control data as a basis for comparison. Meteorological data and pavement conditions as well as material handling and spreading characteristics were recorded for each storm application.

Both the CMA and conventional materials were applied with the spreader trucks regularly used for MDOT maintenance operations (Fig. 2). The hydraulically powered vee-type hopper spreader is equipped with a spinner centered for even distribution across a lane, and with chutes on either side for concentrated dropping of material as required. The spreaders are operated and controlled by the driver from the cab. Calibration of the spreaders permits controlled rates of application ranging from 100 to 1000 lb or more per mile. The units are capable of spreading chemicals alone or mixtures of chemicals and abrasives.

Evaluation of the performance of CMA as compared with salt relied primarily on a series of reports made by the spreader truck driver, the maintenance shift supervisor, and observers from the Materials and Technology Laboratory. The drivers' reports provided data on the size of the load, time of application, length of run, and any loading or handling problems. The supervisors' reports described general weather conditions and

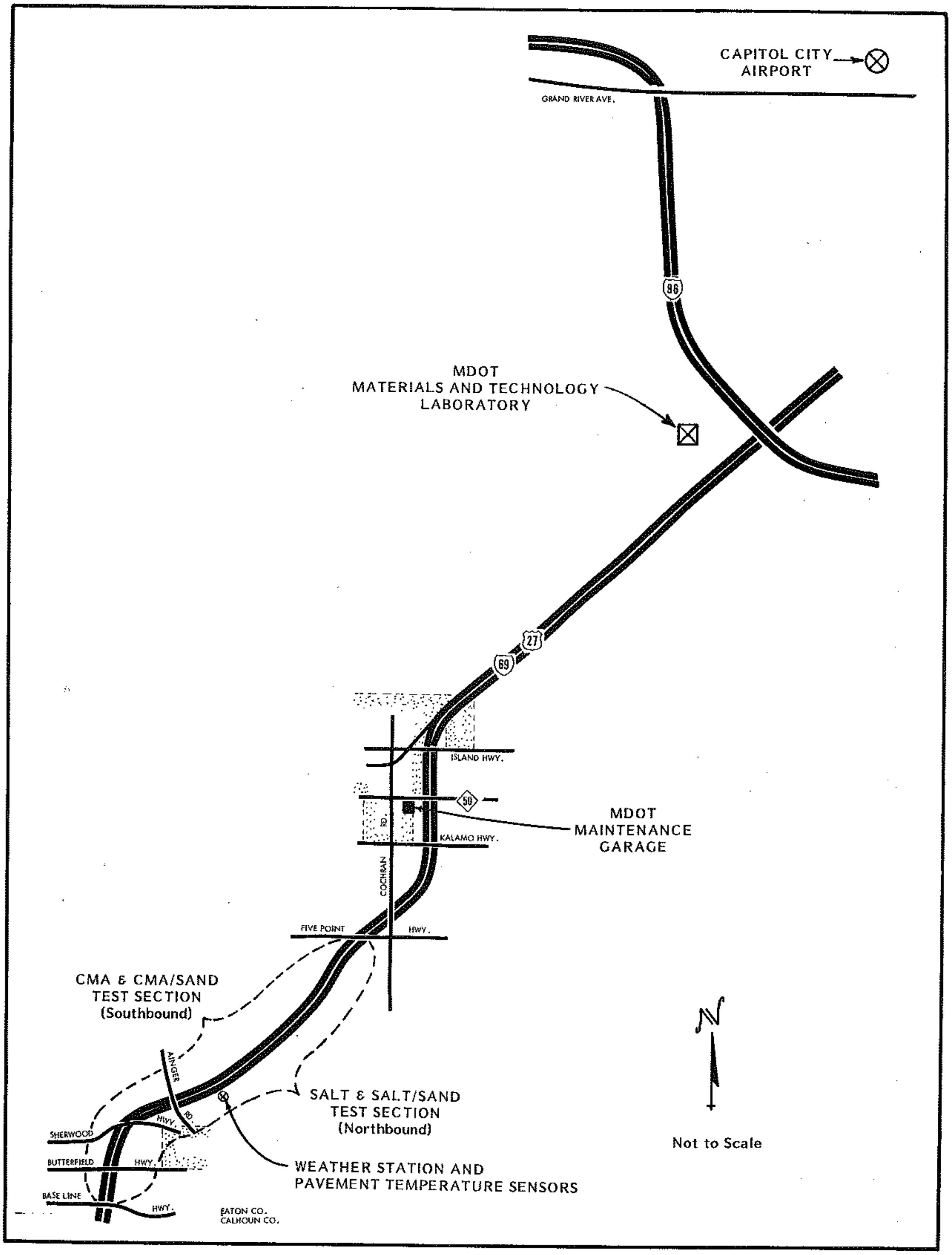

Figure 1. Proposed test sections for comparing CMA and rock salt as ice control chemicals.

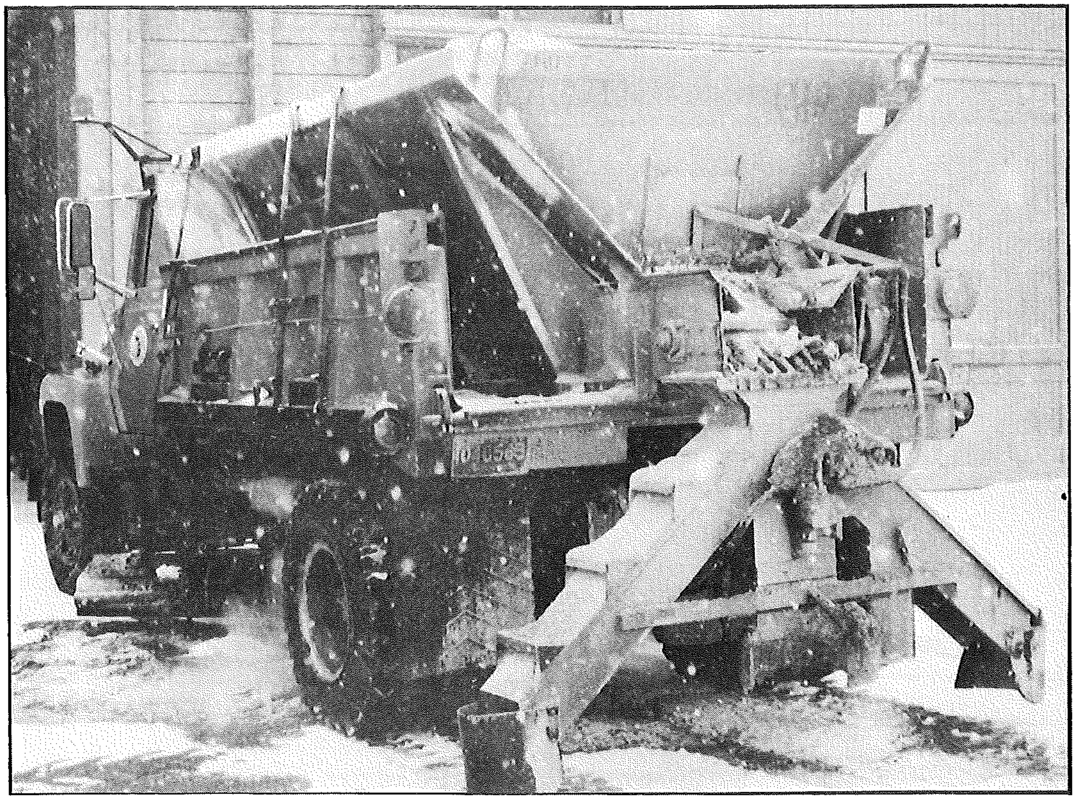

Figure 2. Typical spreader and scraper unit used by MDOT for CMA and rock salt applications.

the spreading and melting action on the road. An observation report by Materials and Technology personnel served to document the melting or clearing rate and overall comparison of the different treatments.

STORM APPLICATIONS

Evaluation of the CMA materials began on January 19, 1987, and continued through February 9, 1988, and involved 17 different storms requiring applications on 21 different days as shown in Table 1. On four occasions, storms began one day and continued well into the next. A weather station was installed in a mobile van adjacent to the northbound roadway test site near Ainger Rd (Fig. 1). Daily pavement temperatures were recorded along with air temperatures in the weather station. Snowfall and precipitation conditions were noted by drivers and maintenance supervisors. An attempt was made to measure precipitation at the site but this feature of the weather station continually malfunctioned and provided no meaningful values. The water equivalent precipitation values shown in Table 1 were obtained from the National Weather Service records for Capitol City Airport in Lansing (about 25 miles northeast of the test site) to provide some measure of each storm's snowfall.

TABLE 1
WEATHER CONDITIONS DURING STORM ACTIVITIES

Storm No.	Date	Daily Air Temp., F	Pavement Temp., F (at APP)	Water Equivalent, in.	Precipitation Conditions
1	1-29-87	21-30	30.5	0.07	Snow chg. to rain
	1-30-87	28-32	32.9	0.15	Light snow
2	2-14-87	9-28	30.3	0.02	Wet heavy snow
3	3-5-87	36-44	34.5	0.03	Wet heavy snow
4	4-1-87	21-48	31.7	0.20	Wet, hardpacked snow
5	12-15-87	30-37	34.8	0.90	Heavy snow chg. to rain
6	12-28-87	26-33	32.3	0.26	Heavy snow
	12-29-87	0-29	24.0	Trace	Wet heavy snow
7	1-5-88	0	9.7	Trace	Light blowing snow
	1-6-88	0	20.2	Trace	Light blowing snow
8	1-13-88	22-26	27.0	Trace	Dry snow, some blowing
9	1-20-88	30	31.0	0.06	Wet heavy snow
10	1-23-88	34	28.2	0.03	Wet heavy snow
11	1-25-88	30	28.5	0.10	Light snow, some blowing
	1-26-88	15	20.3	0.03	Wet heavy snow
12	2-1-88	--	36.0	0.14	Wet heavy snow
13	2-2-88	20	23.0	0.03	Wet heavy snow
14	2-3-88	--	26.0	0.15	Heavy snow
15	2-4-88	8	24.0	0.01	
16	2-5-88	15	21.5	0.05	Light blowing snow
17	2-9-88	--	22.3	0.05	

TABLE 2
CHEMICAL APPLICATIONS AND THEIR COMPARATIVE EFFECTIVENESS

Storm No.	Date	Pavement Temperature, F	Amount of Chemical Applied, tons			Effectiveness[1] Judged by:	
			CMA	CMA-Coated Sand	Salt	Maintenance	M&T
1	1-29-87	30.5	4			3	0
	1-30-87	32.9	7		6	2	3
2	2-14-87	30.3		6*		2	0
3	3-5-87	34.5	4	2	3	3	0
4	4-1-87	31.7		5	3	2	2
5	12-15-87	34.8	23		8	2	0
6	12-28-87	32.3	28		10	2	0
	12-29-87	24.0	9		2	2	0
7	1-5-88	9.7		3*	2	2	0
	1-6-88	20.2		3*	3	3	0
8	1-13-88	27.0	4		3	3	0
9	1-20-88	31.0	2		1	3	3
10	1-23-88	28.2	14	3*	6*	2	0
11	1-25-88	28.5		12	6	2	2
	1-26-88	20.3	9	4	4	2	3
12	2-1-88	36.0		28	2	2	0
13	2-2-88	23.0		6	3	3	3
14	2-3-88	26.0		6*		2	0
15	2-4-88	24.0		7	3	3	0
16	2-5-88	21.5		8	6	3	3
17	2-9-88	22.3		5	1	0	0

*Ramps only and spot treatments.

[1] Effectiveness Scale:

0-No comparison was recorded.
1-CMA was not effective in melting ice or snow where applied.
2-CMA melted ice or snow but not as fast or as completely as rock salt.
3-CMA melted ice or snow equally as fast and as completely as did rock salt.
4-CMA acted more rapidly and completely than rock salt.

The amount of chemicals applied during each storm and their relative effectiveness is summarized in Table 2. Each type of deicing material, CMA or salt, was applied to the same length and width of roadway during a storm. The relative effectiveness was estimated by the drivers and supervisors and also by Research Laboratory technicians.

The rate of melting was documented during daytime storms through a series of photographs taken from the Ainger Rd bridge over the freeway (Figs. 3 through 5). These views were selected as typical.

RESULTS

Applications of CMA and CMA-coated sand were made during 17 different storms. Four storms continued into the next day so that 21 separate and distinct storm days were involved in the data ànlysis. Pavement temperatures ranged from 10 to 36 F for the 21 storm days. Table 3 shows the number of storms occurring for the different pavement temperature ranges involved.

TABLE 3
SUMMARY OF PAVEMENT TEMPERATURE RANGES DURING STORMS

Pavement Temperature Range, F	Number of Storms*
Greater than 32	5
27-32	6
22-27	6
17-22	3
Less than 17	1

*Note that four storms continued into the next day and were counted separately in this table.

During the nine storms in which the 100 tons of CMA were applied, pavement temperatures of from 20 to 35 F were measured and 43 tons of the conventional rock salt material were used. The 100 tons of CMA-coated sand were used during 14 storms; 25 tons, however, were applied on six occasions as either spot treatments or as supplements to straight CMA so that quantitative comparisons were not possible. The other 75 tons of coated sand were applied during eight storms which required the use of 30 tons of conventional rock salt.

Overall, the ratio of CMA to salt was 2.33 (based on weight) with individual storm application ratios of from 1.00 to 3.50 during eight comparative applications. Similar ratios of CMA-coated sand used in eight comparisons with salt varied from 1.35 to as much as 14 with an overall ratio of 2.88.

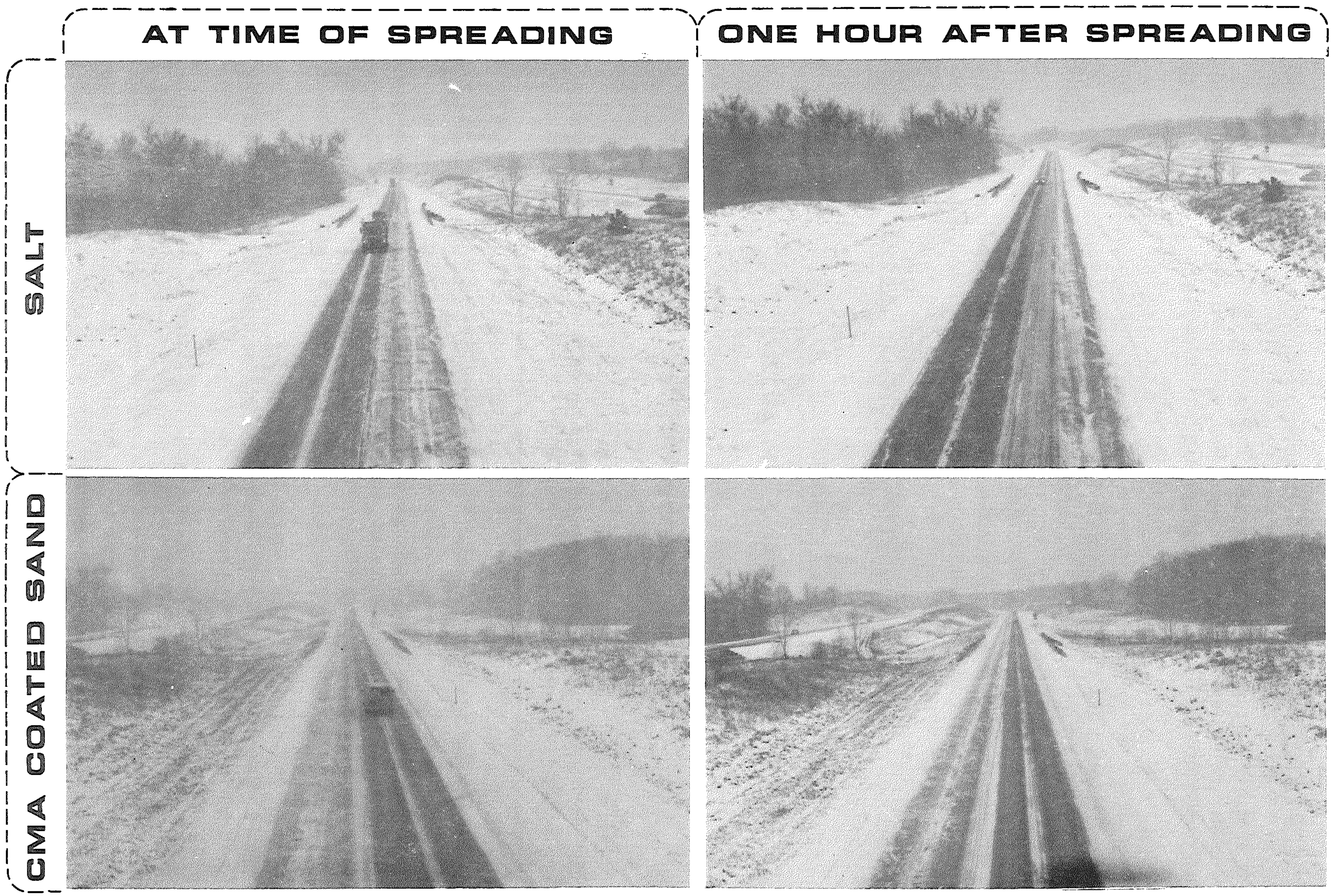

Figure 3. Comparison of CMA coated sand and rock salt on January 25, 1988. Air temperature 30 F, pavement temperature 28 F, CMA to salt ratio: 2 to 1.

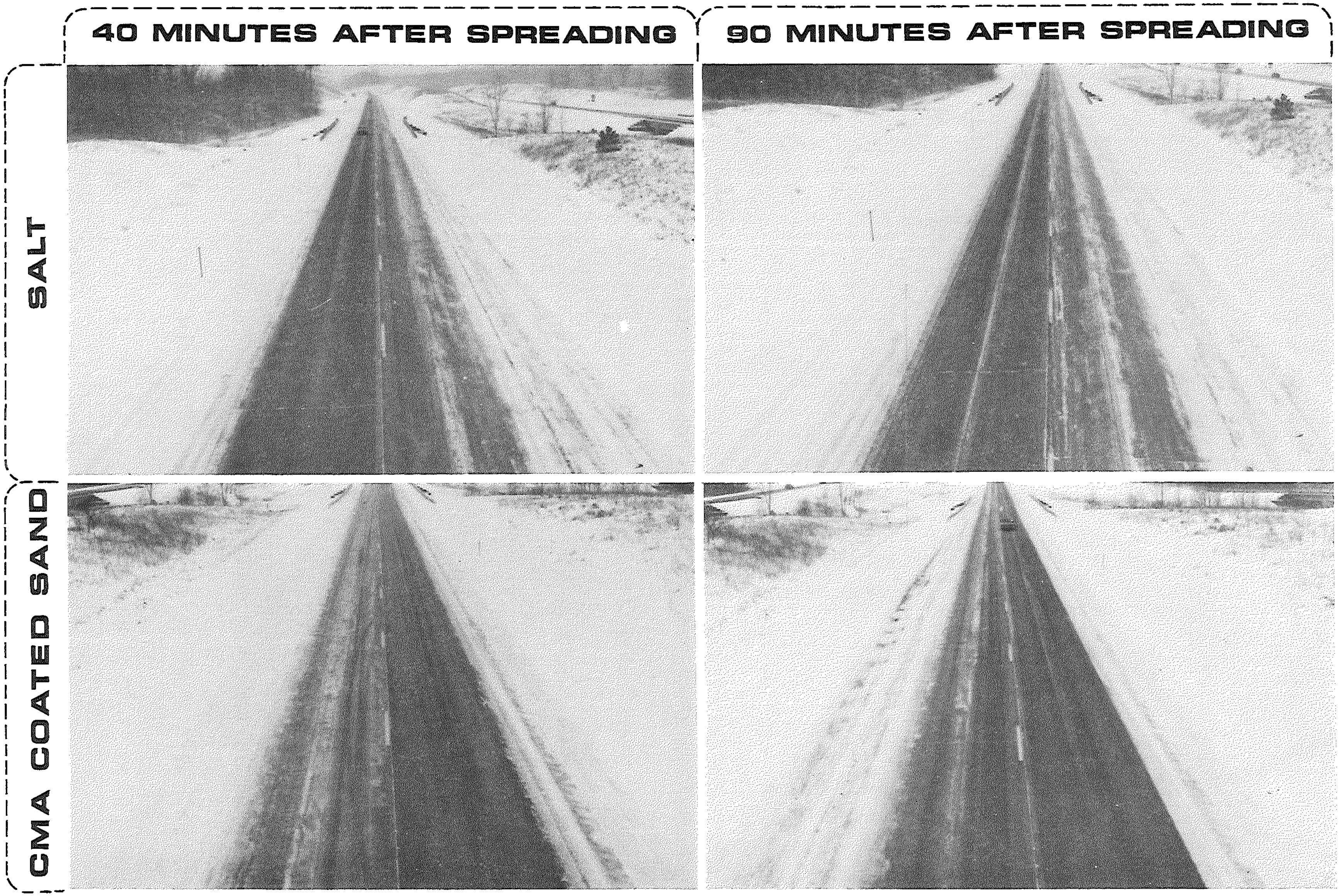

Figure 4. Comparison of CMA and rock salt on January 26, 1988. First of two applications of both chemicals during this storm. Air temperature 15 F, pavement temperature 20 F, CMA to salt ratio: 2.25 to 1.

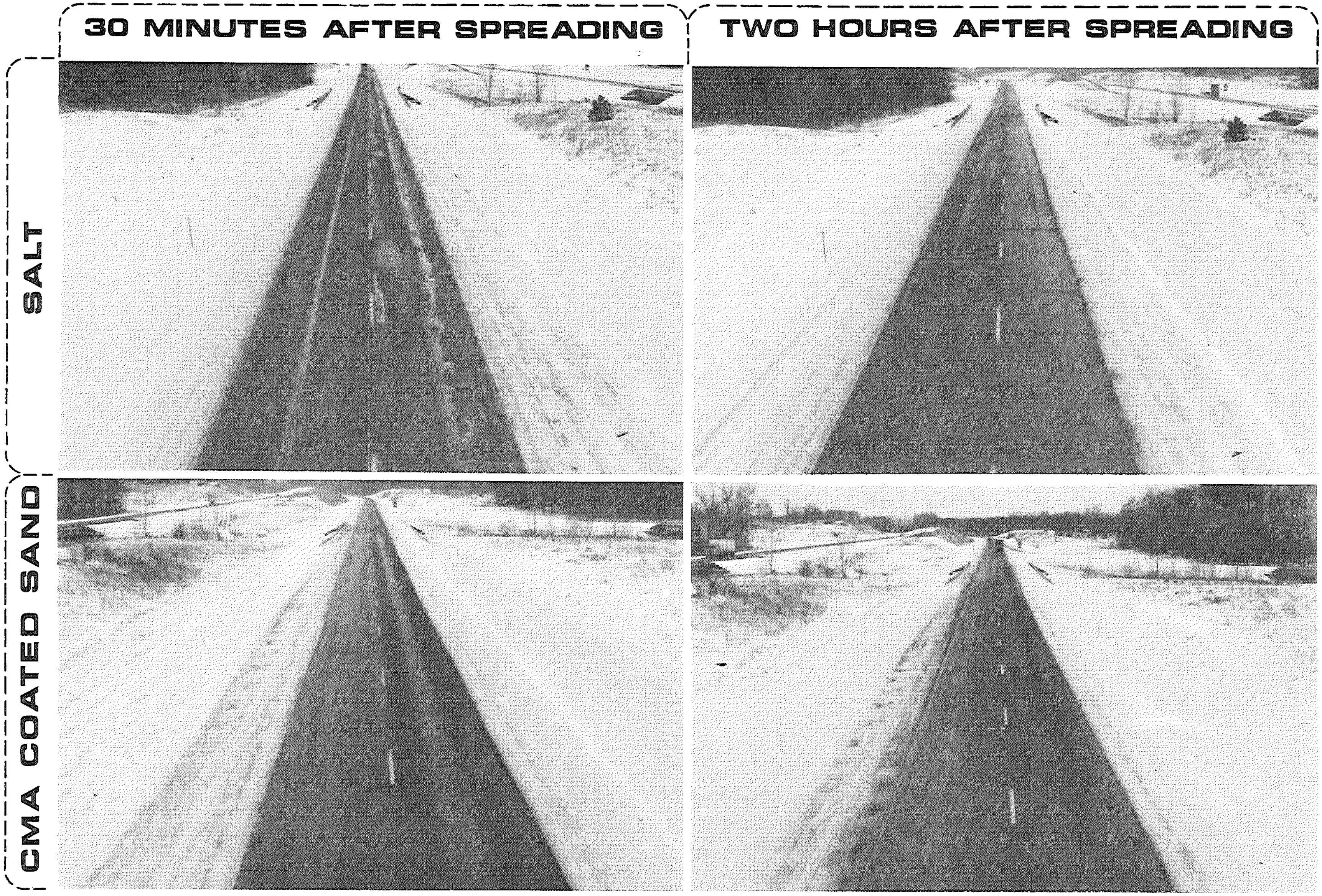

Figure 5. Second application of CMA and rock salt on January 26, 1988. Air temperature 15 F, pavement temperature 20 F, CMA to salt ratio: 2.25 to 1.

Performance of CMA as judged by maintenance personnel centered on effectiveness in melting ice and snow, spreading pattern and action on the pavement, and ease of handling and spreading. Effectiveness was estimated by maintenance operators as somewhat slower and less complete than salt although in six storms the CMA was rated about equal (Table 2).

Spreader truck drivers and maintenance supervisors noted on their reports certain characteristics concerning the behavior of CMA. Prevalent among the observations was the failure of CMA to create a brine and that the material lay on top of the snow pack without penetration to the pavement. It was also noted that the CMA was whipped or blown off the road by traffic during several of the applications. There were also a significant number of more positive comments concerning evidence of strip melting (i.e., melting to the pavement in a narrow strip to provide a wheel track) and observed penetration to the pavement. Throughout the evaluation there were no reports of CMA performing better than salt.

Drivers' comments also emphasized that caking and plugging of equipment was a big problem. The CMA-coated sand, even though quite dusty as compared with straight CMA, did not tend to plug the equipment even though it did cake-on quite readily.

DISCUSSION

It was the intent at the start of the evaluation to apply a sufficient amount of CMA during each storm to achieve approximately equivalent performance. Based on past experience in Michigan it was expected that as much as twice the amount of CMA as rock salt might be required. Spreading equipment was thus calibrated so that application rates varying from 500 to 1,200 lb/mile could be selectively applied by the drivers. During heavier storms further adjustment was necessary in the form of additional application runs with the spreader. These adjustments thus were made in response to both storm and road conditions as perceived by the maintenance operators and supervisors.

Dusting of the CMA has been reduced to an almost negligible level as compared with the previous formulation. With the coated sand, however, the dust levels are as great or greater than that encountered while handling the previous version of CMA. The use of dust respirators by personnel while calibrating and handling the material is still necessary regardless of the form the CMA material is in.

Unit weight of the CMA has been increased from 34 to 50 lb/cu ft which means an increase in particle density has been attained which should result in better penetration of the ice pack, less loss due to blowing off the road, and also more tons per truckload.

CMA for this trial was delivered in 1000-lb bags which reduced storage, handling, and loading problems as compared with the 25-lb bags used in the previous trial. Bulk delivery and storage of this material is possible according to the supplier and would be an even greater improvement.

The covered sheds currently used by MDOT for bulk salt storage would be adequate to prevent exposure to direct rain or snowfall. The newer formulation of CMA seems to cake only slightly when exposed to high humidity. The resultant crust is weak, dries quickly under lower humidity and is easily broken up by manipulation with loading equipment.

Overall, the single greatest drawback to the expanded use of CMA is the extremely high cost (approximately 25 times the cost per ton of rock salt in Michigan). Based on the results of this study, the cost of CMA to achieve equivalent melting capacity of one ton of rock salt would be about $1456.

CONCLUSIONS

Results of this two-winter field evaluation show that for typical southern Michigan conditions CMA as an ice control agent is somewhat less effective than rock salt, even when applied at over twice the rate at which salt is applied. The material cakes-on and plugs the equipment and makes cleanup very difficult.

The new pelletized form of CMA is a considerable improvement over the previously evaluated flake.

The density of the CMA particles has been increased, dust is reduced, and more CMA can be hauled per load, applicability was improved and penetration to the pavement was often noticed, a brine was not formed as readily as with salt.

Despite its shortcomings CMA could be a useful ice and snow control chemical when coupled with appropriate mechanical removal methods.

RECOMMENDATIONS

Based on the results of this field evaluation the following recommendations seem appropriate:

1) Research aimed at reducing the price of CMA should be continued along with further densification of the CMA particles.

2) CMA can and should be used in critical areas where the use of chlorides cannot be tolerated.

3) Laboratory studies now underway concerning the corrosion rates of CMA and CMA-salt mixtures as compared with rock salt alone, should be continued.