1248

# EVALUATION OF CALCIUM MAGNESIUM ACETATE AS AN ICE CONTROL AGENT

## FINAL REPORT

MICHIGAN DEPARTMENT OF TRANSPORTATION



TESTING AND RESEARCH DIVISION
RESEARCH LABORATORY SECTION

# EVALUATION OF CALCIUM MAGNESIUM ACETATE AS AN ICE CONTROL AGENT

## FINAL REPORT

J. H. DeFoe

Research Laboratory Section
Testing and Research Division
in Cooperation with the
Maintenance Division
Research Project 82 G-259
Research Report No. R-1248


Lansing, June 1984

## SUMMARY

Calcium magnesium acetate (CMA) was evaluated by the Michigan Department of Transportation as an alternate to sodium chloride as an ice control agent. This field evaluation was conducted as part of a Pooled Fund Study involving 22 other state agencies and administered by the FHWA. The study consisted of comparative applications of CMA and rock salt on two 6-1/2 mile sections of I 96 during winter storm conditions. A total of 98 tons of CMA was applied using conventional salt spreading equipment during 22 storms in the 1983 and 1984 winter seasons. Results of this evaluation indicate that CMA is effective in melting ice and snow but reacts more slowly than rock salt. It was concluded that CMA could be effective for ice control and snow removal on critical structures where chlorides should not be used.

## INTRODUCTION

The purpose of this study is to evaluate the effectiveness of calcium magnesium acetate (CMA) as an ice control chemical during typical winter maintenance operations in Michigan.

Transportation engineers have been trying for many years to discover deicing chemicals to replace sodium and calcium chlorides which are highly corrosive and cause deterioration of both highway structures and vehicles. Recent research sponsored by the Federal Highway Administration has identified calcium magnesium acetate (CMA) as having the potential of being less polluting and less corrosive than chloride salts.* Their study suggested an economical method for preparing CMA from acetic acid and dolomitic lime.

Using this method for producing CMA, 200 tons were prepared for use in field trials during the 1982-83 winter season. Support for producing the 200 tons of CMA was derived from contributions by 23 states including Michigan under an HP&R pooled-fund arrangement.

At a workshop held in December 1982, representatives from the 23 states in the pooled-fund study developed guidelines for field tests, selected the test states, and developed criteria under which the performance and suitability of CMA would be evaluated. Michigan and Washington were selected as the two states to receive 98 tons of CMA to be field tested. Delivery of the CMA was made in February 1983.

Applications of both CMA and rock salt were made and compared during winter storm conditions. Application rates were varied but were within the range normally used for rock salt applications.

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*Dunn, Dr. Stanley A. and Schek, Dr. Roy V., "Alternate Highway Deicing Chemicals," Federal Highway Administration Report No. FHWA-RD-79-109, March 1980.

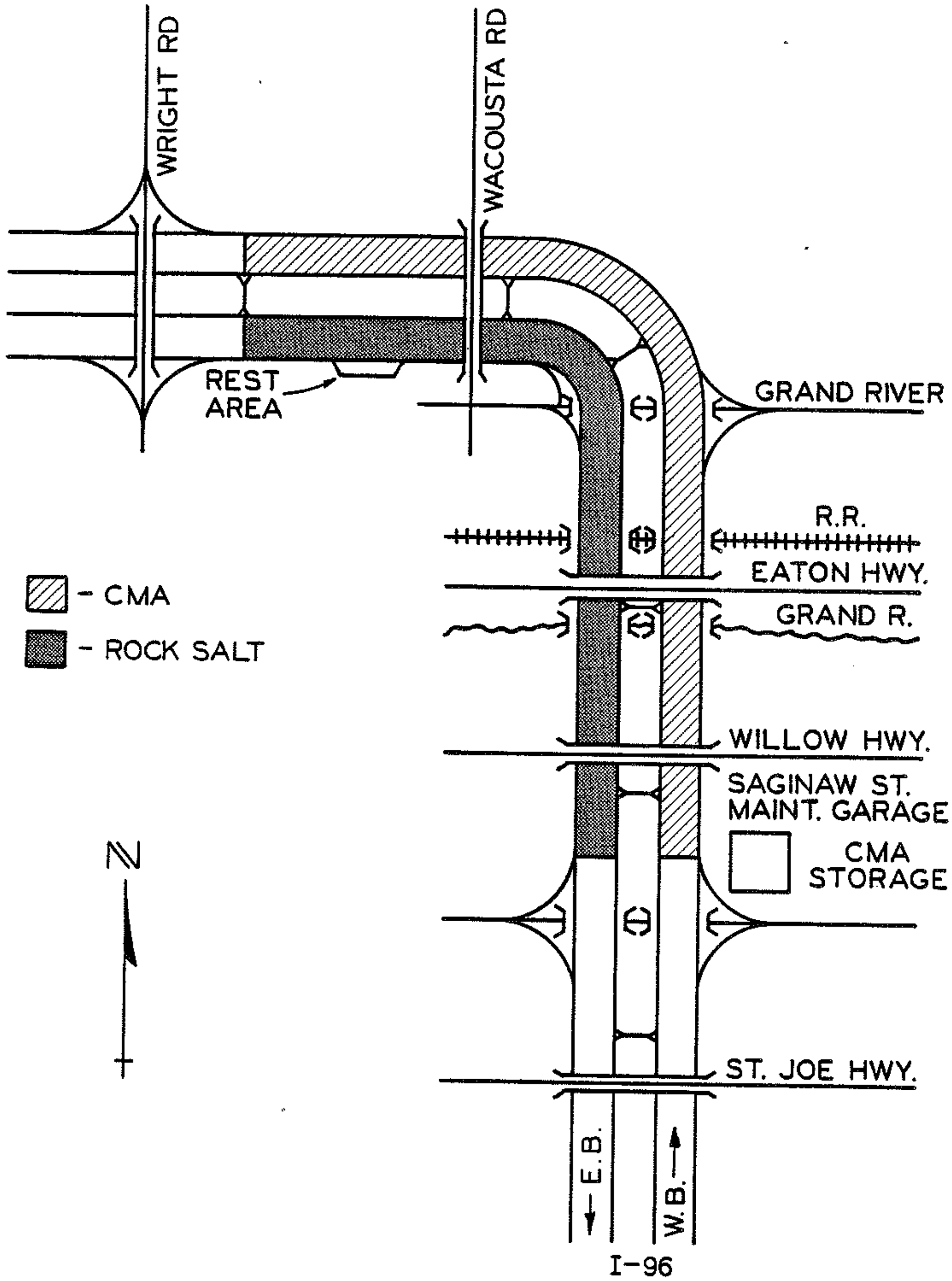



Figure 1. Test sections for comparing CMA and rock salt as ice control chemicals.

## EVALUATION PROCEDURES

Field applications of CMA and rock salt were made on adjacent sections, with comparative traffic volumes and local topography, of I 96 in the Lansing area during winter storm conditions. Figure 1 shows the configuration of the CMA test section and the comparative rock salt control section that were used.

Reports were made on each storm for each of the comparative test sections. The reports included; elapsed time since application, percent of roadway cleared, percent of roadway dry, and length of time required to completely clean the roadway. Any tendency for the pavement to remain moist, resulting in refreezing or blowing snow and buildup, was noted as a significant factor.

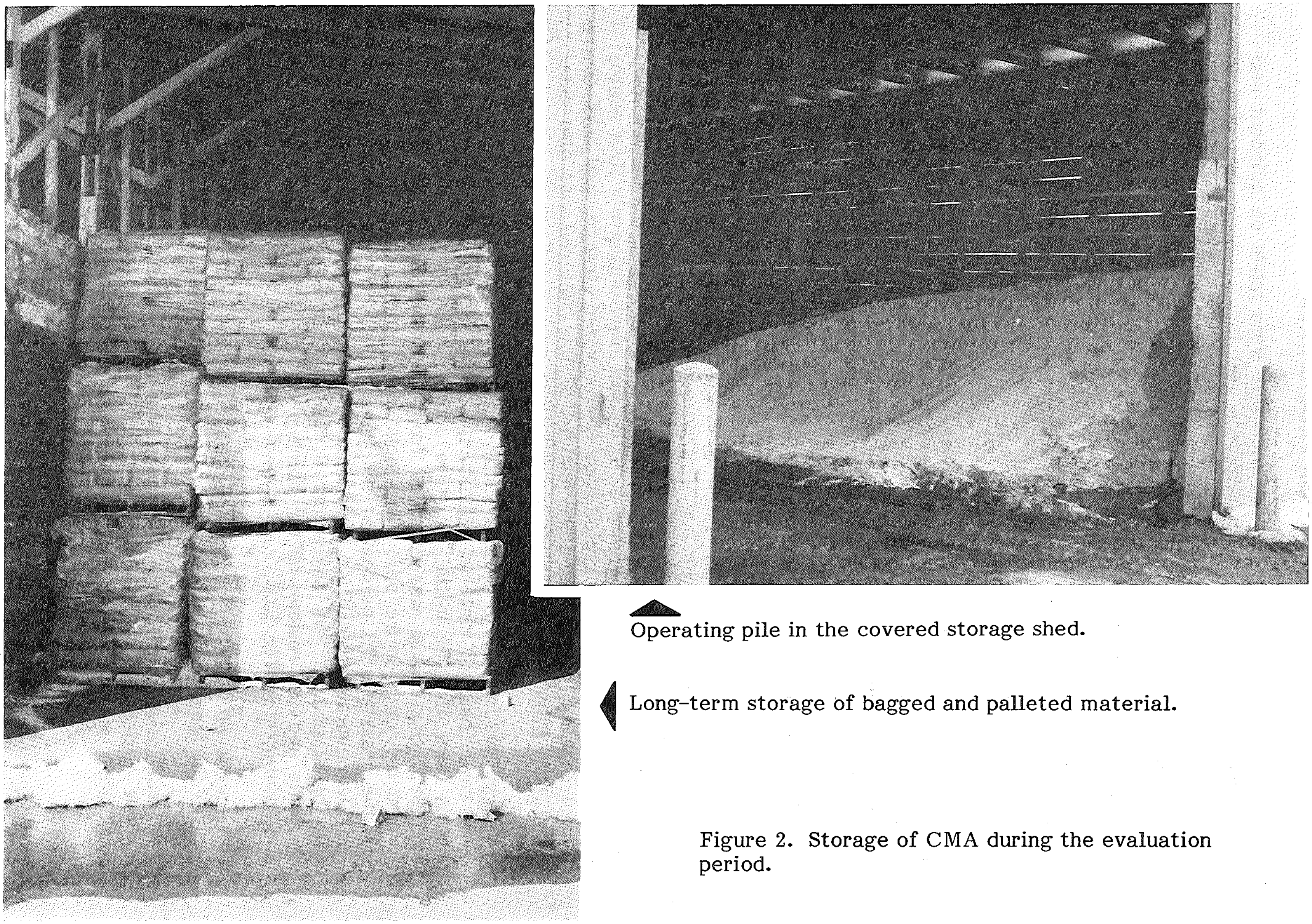
For each storm application, reports were prepared by the driver of the CMA and salt spreader trucks and by observers from the Research Laboratory. The Drivers' Report provided data on the size of load, application rate, and any loading or handling problems. The Evaluation Report described the spread pattern achieved and recorded the melting or clearing rate.

In addition to the ice melting performance, as measured on the road, storage and handling features were also observed and measured. Storm applications were made during two winters, thus requiring storage of some CMA for nearly a year. An operating stockpile was provided in an open-end shed to permit rapid loading of trucks during storms (Fig. 2). Moisture content and crusting of this pile were measured and observed periodically. CMA was loaded from the operating storage pile into a conventional salt spreader as shown in Figure 3. CMA not used during the first winter was stored in the original sealed bags in a covered storage shed until the second season (Fig. 2). Moisture content of this material was also measured seasonally.

On May 17, 1983, a small outside stockpile of CMA was constructed using seven bags of material placed on a plywood base and covered with canvas (Fig. 4). The initial moisture content was 1.9 percent. On June 10, 1983, the canvas was removed from the stockpile; thick crust had formed over the entire pile. The moisture content of the stockpile below the crust was 5.1 percent at that time. The crust was removed from the pile, several bags of CMA were added, and the pile reshaped and covered with black plastic. On September 9, 1983, pictures were taken of the stockpile and the residue of the black plastic which had become brittle and disintegrated (Fig. 5).

Samples of CMA were obtained throughout the evaluation period from each of the storage modes and tested for moisture content.

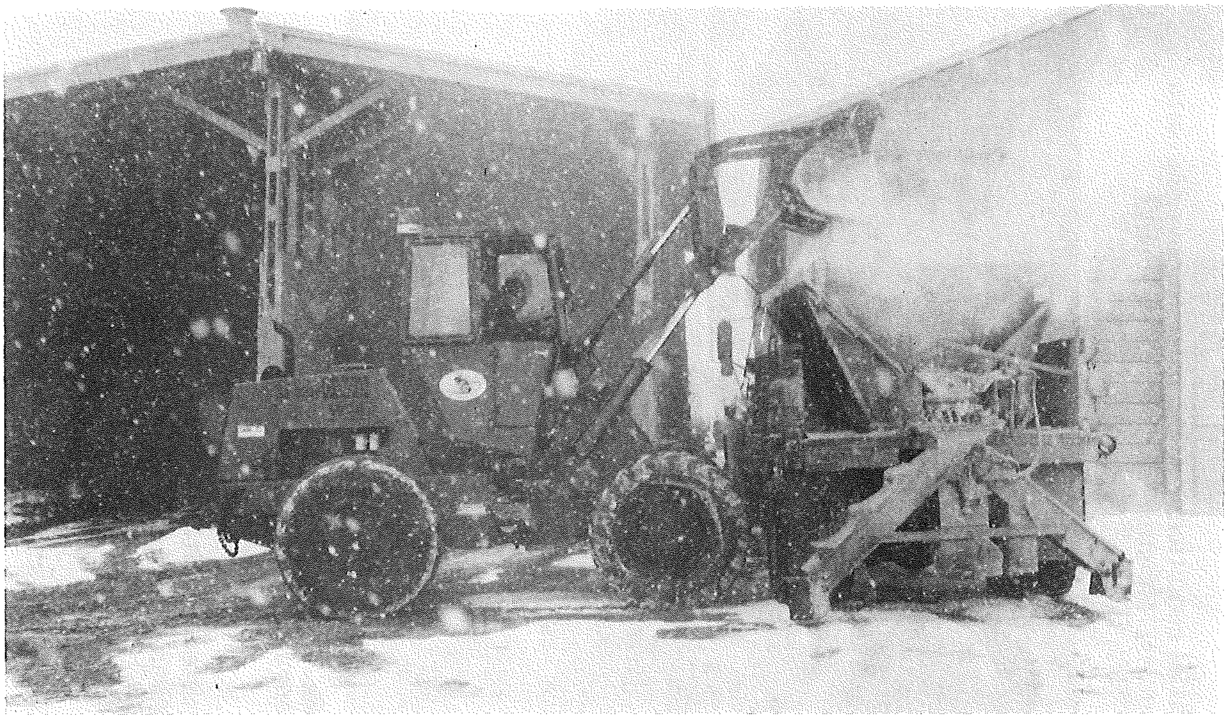
During the first winter CMA was applied at equal application rates (weight basis) with comparative salt applications. A review of results by Testing and Research, Maintenance, and the Federal Highway Admin-



Operating pile in the covered storage shed.

Long-term storage of bagged and palleted material.

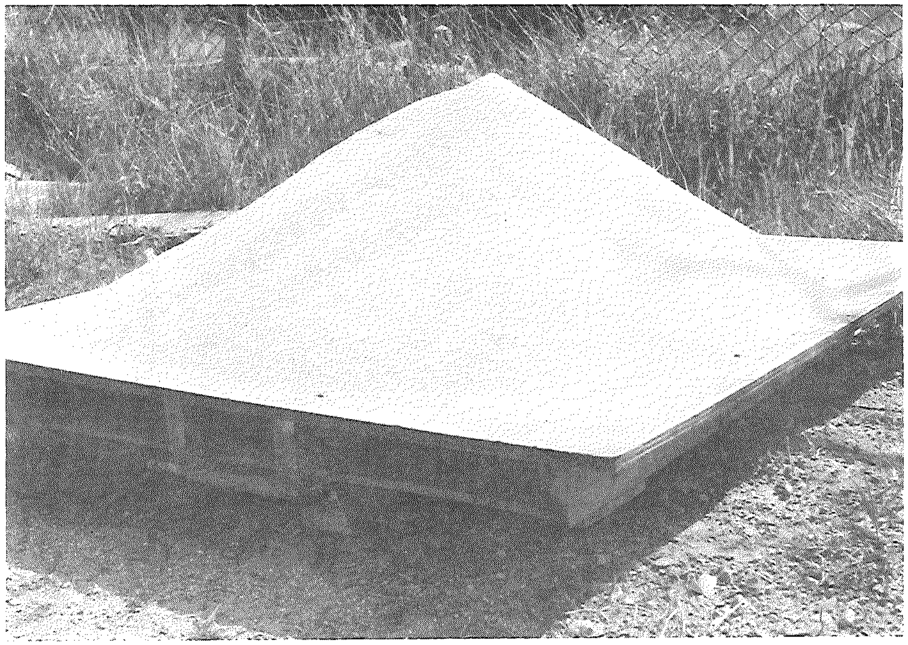
Figure 2. Storage of CMA during the evaluation period.



Loading CMA into spreader truck. Note CMA dust at upper right.

CMA application on test section is the dark band behind the truck near the centerline.

Figure 3. Loading and applying CMA.



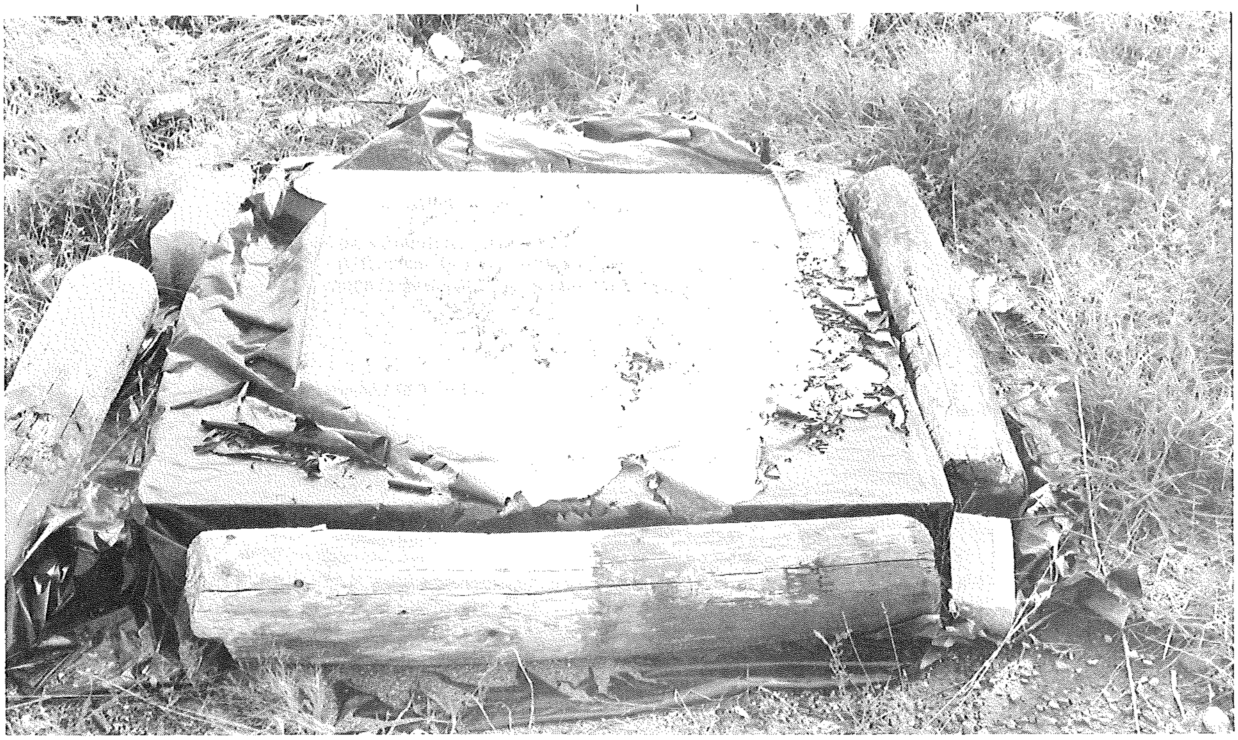
Initial condition of CMA prior to covering with canvas. Moisture content 1.9 percent.

Canvas cover in place.

Crusted condition of CMA after one month under canvas. Moisture content 5.1 percent.

Figure 4. Experimental storage of CMA under canvas cover.

Initial condition of plastic covered pile.



Condition of stockpile and plastic cover after three months.

Figure 5. Storage of CMA under plastic cover.

## TABLE 1
## CMA STORM APPLICATIONS

| Storm No. | Date | Temperature, F | Storm Conditions | Effectiveness[1] Research/ Maintenance | CMA Applied, Tons |
|---|---|---|---|---|---|
| 1 | 3-20 to 3-22-83 | 17 to 26 | Continuous snowfall with strong winds and drifting. Heavy snowpack build-up of 2 to 3 in. Total snowfall of over 8 in. | 1/1 | 18-1/2 |
| 2 | 3-28-83 | 31 to 38 | Light snow, minor accumulation with slush under bridges. | 3/3 | 1 |
| 3 | 11-11-83 | 32 | Wet snow, windy, warming. | /2 | 1 |
| 4 | 11-29-83 | 30 | Trace of snow, slight icing in protected areas. | 0 | 1 |
| 5 | 12-1-83 | 25 | Light snow, glaze of ice in traffic lane. | 0 | 1/2 |
| 6 | 12-4-83 | 26 | Freezing rain, iced roadway - second application CMA needed on bridge deck. | /2 | 2 |
| 7 | 12-5-83 | 32 | Continuous heavy snowfall. | /3 | 3 |
| 8 | 12-6-83 | 22 | Blowing snow - second application CMA needed. | /2 | 9 |
| 9 | 12-9-83 | 26 | Continuous heavy snow, snowpack between wheel paths - three CMA applications needed. | /2 | 9 |
| 10 | 12-14-83 | 30 | Light rain, freezing on bridge decks only - four passes CMA per deck were needed. | /2 | 1/2 |
| 11 | 12-21-83 | 24 | Thin ice layer on pavement. | 3/2 | 9 |
| 12 | 12-22-83 | 22 | Blowing snow sticking to moist pavement. | 3/2 | 6 |
| 13 | 12-28-83 | 17 | Heavy snow with some blowing. | 3/ | 1/2 |
| 14 | 1-1-84 | 23 | Light snow. | /2 | 3 |
| 15 | 1-2-84 | 24 | Light snow with some glazing. | 3/2 | 3 |
| 16 | 1-5-84 | 32 | Light snow, warming, spreader was plugging. | /2 | 1-1/2 |
| 17 | 1-13-84 | 14 | 1-in. snowfall and blowing, double application to two lanes, 36 miles. First attempt at sand-CMA mix; mixed prior to loading; caked up and clogged spreader. | /2 | 12 |
| 18 | 1-14-84 | 18 | Light snow, icy spots. | 3/2 | 3 |
| 19 | 1-17-84 | 19 | Continuous light snow, packing to ice, CMA/sand mix 1:1. | 3/3 | 3 |
| 20 | 1-23 and 1-24-84 | 28 | Freezing rain, ice, CMA/sand mix 2:1. | 3/2 | 4 |
| 21 | 1-27-84 | | Light freezing rain mixed with snow, CMA/sand mix 2:1. | 3/ | |
| 22 | 1-28 and 1-29-84 | 26 | Snow and blowing changed to freezing rain, CMA/ sand mix 2:1. | /4 /3 3/3 | 4 |

[1] Effectiveness Scale: The left-hand number is the rating assigned by a representative from the Research Laboratory, the right-hand number was assigned by the driver, representing the Maintenance Division.

0 - No comparison was recorded. This response usually occurred when a small amount of CMA was applied to isolated spots with no corresponding salt application.
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.

istration prompted a change in the CMA rate to twice that used for rock salt during the remainder of the evaluation.

CMA mixed with sand was applied during the final five storms of the evaluation. A one-to-one mixture was tried first but a two-to-one mixture of CMA to sand was found to handle better and be more effective and was used during the last three storms. The decision to use sand was coordinated with the Maintenance Division as well as with the Contracting Officers Technical Representative from the FHWA and was an attempt to accelerate ice cutting action and to reduce the amount of material blown from the roadway.

Quarterly progress reports were prepared throughout the project and are included in the Appendix.

Physical characteristics of CMA were measured prior to beginning the study and are presented below.

CMA Characteristics

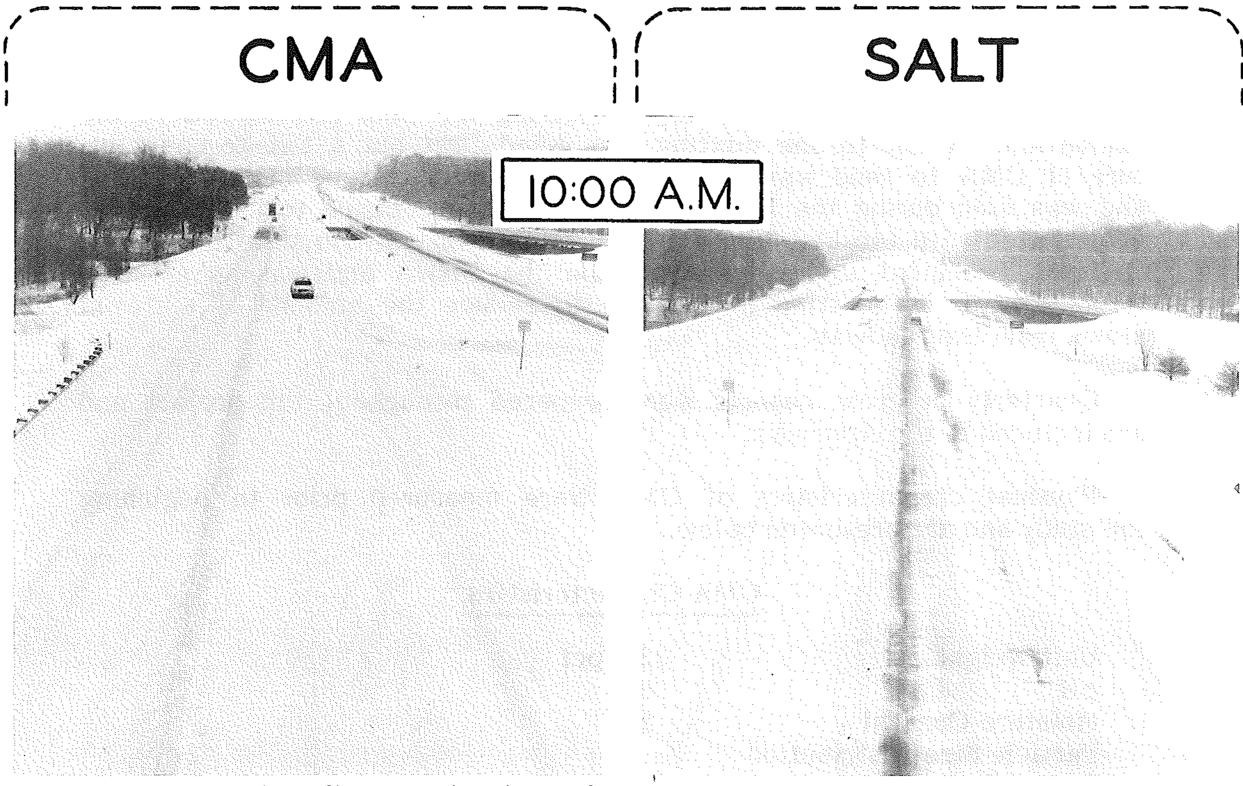
| | |
|---|---|
| Unit Weight | 33.8 pcf |
| pH | 9.7 |
| Moisture Content | 2.2 |
| Particle Size Distribution | |

| Sieve Size | % Passing |
|---|---|
| #8 | 99 |
| #10 | 89 |
| #16 | 19 |
| #30 | 2 |

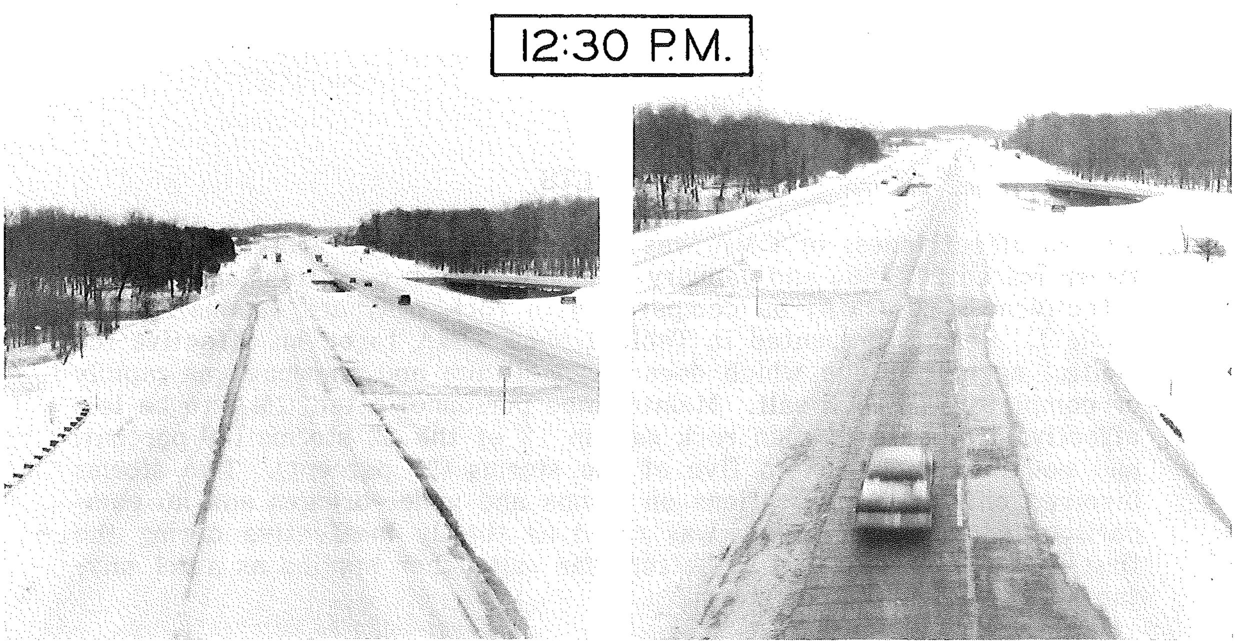
## RESULTS

The effectiveness of CMA was evaluated during 22 winter storms between March 20, 1983 and January 29, 1984. Storm conditions and relative effectiveness of CMA, as compared with rock salt, are summarized in Table 1. Results presented in Table 1 show CMA to be an effective ice control agent but one which does not melt ice and snowpack as rapidly or completely as rock salt. Maintenance personnel rated CMA to be less effective (response 2) than rock salt in 13 of the 22 storms (59 percent) and equal to rock salt in five of the storms (23 percent). Two storms involved only spot applications on ramps and under bridges and no comparisons were made. CMA was rated as totally ineffective during the first storm but was rated as better than salt (when applied as a 2:1 mixture with sand) during one storm.

A series of photographs, Figure 6, taken during the storm on March 22, 1983 illustrated the relative effectiveness of CMA as compared with




One hour after first applications of CMA and salt and immediately after a second application of both materials.




Three and one half hours after first applications of CMA and salt.

Figure 6. Effectiveness of CMA and rock salt on comparative test sections covered with packed snow and ice.

rock salt. During this prolonged storm (three days) an 8-in. snowfall was recorded causing a significant buildup of snowpack in the roadways. The heavy snowfall had ended before either CMA or salt began to be effective, when the photos were taken. A detailed description of this storm was previously reported and is included in the Appendix.

Driver's storm reports for the 22 storms, summarized in Table 2, show that a total of 94.5 tons of CMA was used in 54 applications. Using the tabulated load weights and applications (each application consisted of one pass with the spreader over the 6.2 mile long section, i.e., 6.2 lane miles), an application rate of 564 lb/lane mile was calculated as compared to the 613 lb/lane mile rate as obtained by averaging the spreader rates reported for the individual storms by the drivers.

Considering that the tonnage for each load was estimated by the drivers on the basis of front-loader scoops, 94.5 of 98 tons delivered seems to be a reasonably accountable value.

Salt usage was not as well documented, however, but reports were made for six storms which permitted some comparison of the relative amounts needed to achieve the respective ice control levels obtained for each material. During six storms, in which both the salt spreader rate and load weights were reported, 11 tons of salt were used in six applications (storms marked * in Table 2) for a calculated application rate of 322 lb/lane mile. The average of the reported spreader rates equaled 336 lb/lane mile.

Based on the average spreader rate values for the six comparable storms, a 1.9 to 1 ratio of CMA to salt was required to achieve an equivalent effectiveness for the two materials. If, however, the estimated tonnage values and the number of applications are used to make the comparison for the six storms, a ratio of 2.64 to 1 of CMA to salt is indicated.

Moisture content of the CMA was measured at various phases throughout the project as follows:

| | | |
|---|---|---|
| February 1983 | Sampled from shipping bags at the time of delivery | 2.2% |
| May 11, 1983 | Sampled from interior of inside operating stockpile | 7.3% |
| May 17, 1983 | Sampled from bags which had been stored inside since delivery | 1.9% |
| June 10, 1983 | Sampled from interior of the outside covered pile (after three weeks in pile) | 5.1% |
| September 9, 1983 | Sampled from inside operating stockpile | 5.7% |

## TABLE 2
## CMA STORM APPLICATION HISTORY

| Storm No. | Date | Temperature, F | Effectiveness[1] by Maintenance | CMA Applied Load Weight, Tons | No. of CMA Applications | Spreader Rate, Lb/Lane Mile CMA | Salt Applied, Tons | No. of Salt Applications | Spreader Rate Lb/Lane Mile Salt |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 3-20 to 3-23-83 | 17 to 26 | 1 | 18-1/2 | 7 | 533 | 4 | 4 | 336* |
| 2 | 3-28-83 | 31 to 38 | 3 | 1 | 1 | — | 1 | 1 | — |
| 3 | 11-11-83 | 32 | 2 | 1 | 1 | — | - | 1 | 500 |
| 4 | 11-29-83 | 30 | 0 | 1 | 1 | 286 | - | - | — |
| 5 | 12-1-83 | 25 | 0 | 1/2 | 1 | 500 | - | - | — |
| 6 | 12-4-83 | 26 | 2 | 2 | 1 | 444 | 1/2 | 1 | 403* |
| 7 | 12-5-83 | 32 | 3 | 3 | 2 | 500 | 1 | 1 | 333* |
| 8 | 12-6-83 | 22 | 2 | 9 | 3 | 1000 | 2 | 2 | 333* |
| 9 | 12-9-83 | 26 | 2 | 9 | 3 | 667 | 2 | 2 | 278* |
| 10 | 12-14-83 | 30 | 2 | 1/2 | 5 | 800 | - | 1 | — |
| 11 | 12-21-83 | 24 | 2 | 9 | 3 | 667 | - | - | — |
| 12 | 12-22-83 | 22 | 2 | 6 | 2 | 667 | 1-1/2 | 1 | 333* |
| 13 | 12-28-83 | 17 | 0 | 1/2 | 2 | — | - | - | — |
| 14 | 1-1-84 | 23 | 2 | 3 | 1 | 667 | - | - | — |
| 15 | 1-2-84 | 24 | 2 | 3 | 1 | 667 | - | - | — |
| 16 | 1-5-84 | 32 | 2 | 1-1/2 | 2 | 333 | - | - | — |
| 17 | 1-13-84 | 14 | 2 | 12 | 4 | 667 | - | - | — |
| 18 | 1-14-84 | 18 | 2 | 3 | 1 | 667 | - | - | — |
| 19 | 1-17-84 | 19 | 3 | 3 | 4 | 667 | - | - | — |
| 20 | 1-23 and 1-24-84 | 28 | 2 | 4 | 4 | 667 | - | - | — |
| 21 | 1-27-84 | | 0 | - | - | — | - | - | — |
| 22 | 1-28 and 1-29-84 | 26 | 3 | 4 | 5 | 639 | - | - | — |
| * Total tons, 6 comp. storms | | | | 47.5 | | | 11 | | |
| Total tons, 22 comp. storms | | | | 94.5 | | | 12 | | |

[1] Effectiveness Scale:

0 - No comparison was recorded. This response usually occurred when a small amount of CMA was applied to isolated spots with no corresponding salt application.
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.

| | | |
|---|---|---|
| October 3, 1983 | Crust over inside operating stockpile | 32.1% |
| October 3, 1983 | Uncovered outside pile (all crust) | 38.1% |
| November 4, 1983 | Sampled from bags stored inside since delivery | 2.7% |
| January 17, 1984 | Sampled from interior of operating pile inside the storage shed | 2.8% |

A moist crust of caked CMA formed over the top of each stockpile. The crust seemed to increase in thickness as long as it was undisturbed. Moisture measurements were made on the crusted material which ranged from 32 to 42 percent; the crusted layer was discarded since it could not be broken up to pass through the spreading equipment.

Even though the moisture within the operating pile had decreased to some extent (7.3 to 5.7 percent), the formation of a thick crust shows the need for careful storage procedures.

CMA sticks to equipment and rapidly builds a thick, caked mass which plugs openings and stops the spinner on the spreader. Because of the plugging action the spinner had to be removed and the CMA dropped directly through a chute to the pavement. This resulted in a spread path approximately 2 ft wide, as shown in Figure 3, which helped to retain and concentrate the CMA on the road. Previous applications using the spinner not only resulted in dispersing the material laterally 6 ft or more but exacerbated the blowing off by wind and traffic. An additional half hour or more was required for clean-up of the CMA spreader over that required for the salt unit.

### Other Tests

In addition to the evaluation of CMA as an ice control chemical the Research Laboratory is also conducting laboratory studies to measure any detrimental effects of CMA on various metals, concretes, and grouting mortars. Results of these studies will be published as separate reports when completed.

## CONCLUSIONS

Results of this evaluation show that CMA can be an effective ice control and snow removal chemical even though it does not melt ice and packed snow as rapidly or completely as salt. Other specific findings of this study are:

1) Two to three pounds of CMA for every pound of salt must be applied in order to achieve a comparable degree of effectiveness.

2) The relatively light weight of CMA (34 lb/cu ft) results in loss due to blowing from the road and from equipment.

3) CMA does not penetrate ice and packed snow because of its light weight. Penetration is needed in order to form a liquid solution on the road surface in order to enhance breakup of the ice or snowpack.

4) Light fine dust from CMA makes the use of respirators a necessity during the loading and handling of CMA.

5) CMA readily absorbs moisture and forms a sticky caked mass which tends to clog equipment and which is difficult to clean from clothing as well as from equipment.

6) CMA having a moisture content of up to 7.3 percent was flowable and could be applied through the spreader as finally modified for the major portion of this study.

7) The use of the 2:1 CMA-sand mixture seemed to improve the deicing action as compared with using CMA alone.

## RECOMMENDATIONS

The following recommendations are based on the results of this study and are pertinent to the use of CMA in the form which was evaluated, i.e., as dry pellets.

1) At current prices ($500/ton) CMA should be used only on large critical structures where the use of chlorides cannot be tolerated.

2) Mechanical removal of as much snow and ice as possible should precede each application of CMA. This combined treatment should be repeated frequently during heavy, or prolonged snowfalls; there is almost no long-term interaction with traffic as there is with salt.

3) Improved methods of storage and handling should be developed. Bulk storage in silos with a pneumatic system for spreader loading would be one approach. The spreader box should be covered or perhaps a closed pneumatic application system should be developed for the spreader vehicle.

4) CMA and sand mixtures should not be used on critical structures because the sand would clog drainage appurtenances and expansion joints.

Finally it is recommended that the feasibility of applying CMA in a liquid or slurry form be investigated. This should reduce the cost of CMA (drying would be eliminated in production) and would eliminate the handling problems associated with the dry form of CMA.

## APPENDIX

(NOTE: Photographs accompanying some of these letter reports have been omitted, since they appear in the text of the report.)

# OFFICE MEMORANDUM

*DATE:* February 16, 1983

*TO:* J. H. DeFoe - Supervisor
Soils & Bituminous Mixtures Group

*FROM:* P. T. Luce

*SUBJECT:* Friction Measurements on Constructed Ice, De-Icing Agents
Research Projects 54 G-74 and 82 G-259

In response to your request, surface friction measurements were conducted February 11, 1983, at the two constructed ice test locations on structures carrying unopened I-69 over Turner Road.

Measurements were performed on prepared ice test sections before and immediately after application of deicing materials and continued at regular intervals for two hours. Due to test section differences caused by texture variation, only small portions of force trace recordings were deemed suitable for friction level analysis. Since this undesired texture influence increases with time, especially on the EBOL test section, only those single measurements performed before and immediately after deicing applications were used to compute friction levels presented here for comparison.

| Test Location | Deicing Agent | Coeff. of Friction* Before | After |
|---|---|---|---|
| EBOL | CMA | 0.15 | 0.21 |
| WBOL | Salt | 0.15 | 0.16 |

Observations made by friction test personnel include:

(1) Test tire tracking (leaving ice) from surface melting was greater on the EB (CMA) section.
(2) Deicing material penetration was greater for the larger particle salt material.

(*) As measured by 2 wheeled towed trailer with ASTM E 501 test tire at a test speed of 10 mph and no water applied.

TESTING AND RESEARCH DIVISION

P. T. Luce - Engineering Technician
Pavement Performance Group

STATE OF MICHIGAN

TRANSPORTATION COMMISSION

JAMES J. BLANCHARD, GOVERNOR

DEPARTMENT OF TRANSPORTATION

TRANSPORTATION BUILDING, 425 WEST OTTAWA PHONE 517-373-2030

POST OFFICE BOX 30050, LANSING, MICHIGAN 48909

JAMES P. PITZ, DIRECTOR

February 28, 1983

Dr. Brian Chollar, Materials Division
Office of Research and Development
U. S. Department of Transportation
Washington, D.C. 20590

Dear Dr. Chollar

CMA Field Test - Interim Progress Report

The first deliveries of CMA arrived at the Grand Ledge Garage on Tuesday, February 8, 1983. The shipments were in good condition, packaged in 25 lb. paper bags similar to those used for fertilizer. The last loads of our alloted 98 + tons were received on Tuesday, February 15, 1983.

Preparation of the test vehicle and calibration of the spreader box was completed on Wednesday, February 9, 1983. Guidelines for the field test, application and reporting procedures were reviewed and discussed with the field supervisor, vehicle operators and observers.

A trial application of CMA was conducted on Friday, February 11, 1983. The test was performed on a closed section of recently completed I-69 Freeway north of Lansing. The objective was to determine if any equipment modification was needed, to observe the spreading pattern and to perform friction tests. The weather conditions were good, as it was clear, sunny with little wind and a temperature of 20°F. No equipment modifications were required and the observed spreading pattern was considered good.

The friction tests (ASTM E274) were made on iced sections of pavement using our Testing and Research Division's two-wheeled tow trailer with ASTM #501 test tire.

Due to problems with the watering truck used to create an ice layer on the pavement the night before, a shorter than intended test section was prepared. Measurements taken on the iced sections, although limited in extent, did allow a suitable friction level analysis.

General observation of the melting action of the CMA application as compared to a parallel application of NaCl indicated very similar results.

In regards to handling the CMA material in bulk form, a substantial amount of dust is produced. This was observed while workmen were dumping the material into the bulk stock pile and while loading the spreader box with the front end loader. The dust was considered great enough to require the men handling the material to wear protective dust masks. The dust tends to form a sticky film that adheres to clothing and equipment. In discussions with Mr. Marynowski of SRI International, he indicated the material was produced with a higher than specified fines content.

We are now ready to proceed with the field testing of CMA in accordance with our previously prepared work plan, awaiting only the arrival of storm conditions requiring snow and ice control operations.

As requested in your letter dated February 8, 1983, quarterly progress evaluation reports will be submitted by Jack DeFoe, Research Project Leader.

Sincerely yours,

Donald E. Orne
Engineer of Maintenance

STATE OF MICHIGAN

JAMES J. BLANCHARD, GOVERNOR

DEPARTMENT OF TRANSPORTATION

RESEARCH LABORATORY SECTION SECONDARY GOVERNMENTAL COMPLEX
POST OFFICE BOX 30049, LANSING, MICHIGAN 48909
PHONE: (517) 322-1632

JAMES P. PITZ, DIRECTOR

March 28, 1983

Dr. Brian H. Chollar
Materials Technology and
Chemistry Division, HNR-40
Federal Highway Administration
Washington, D.C. 20590

Dear Dr. Chollar:

As we discussed in our March 25, 1983 telephone conversation I am sending a narrative describing Michigan's first winter storm experience with CMA.

Enclosed you will also find photographs, driver reports and a tabulated summary of CMA and salt applications.

Results do not seem encouraging but I believe some valuable information was obtained from this storm which was probably more severe than many typical storms in Michigan.

Sincerely,

TESTING AND RESEARCH DIVISION

J. H. DeFoe - Supervisor
Soils & Bituminous Mixtures Research

CMA-Storm and Treatment History

Sunday March 20 through Tuesday March 22, 1983

The storm started around 6:00 PM Sunday, and ended Tuesday morning with a total snowfall of over 8 inches. Winds of up to 20 mph caused considerable drifting. An extensive period of warm weather preceded the storm so that pavement temperatures were warm enough to result in considerable sticking and packing of the snow by traffic. Snowfall ended Tuesday morning with blowing and drifting stopping before Noon.

CMA and salt were applied on Sunday evening at 7:00 PM and 9:00 PM, respectively, but neither were effective due to the intensity of the storm. Continuous blading was required until mid-day on Monday to keep the highway open and the snow pack remained 1 to 2 inches thick during this time. The next applications of CMA and salt were made on Monday at Noon but because of continued storm conditions and low temperatures (18°F) neither was effective. CMA was applied again at 3:00 PM and 5:00 PM with no effect.

The snow pack remained over both roadways until Tuesday morning when some melting was observed in both roadways. Sunshine and wind abatement aided subsequent clearing operations. CMA applications were made on Tuesday at 8:45 AM, 10:00 AM, and 10:45 AM with little or no effect on the snow pack.

The 8:45 application was at the rate of 422 lbs/mile while the 10:00 and 10:45 applications each consisted of three passes at 780 lbs/mile for each pass. The pavement began to clear on the salt section soon after the first application and progressed rapidly throughout Tuesday morning. One lane was clear by 11:00 AM and other lanes were breaking up. Snow pack remained over the CMA section until about Noon on Tuesday when salt was then applied. Salting was necessary to clear the surface of all snow pack and slush as temperatures near zero were predicted for that night. Both roadways were completely clear and dry by 4:00 PM Tuesday.

Photographs were obtained throughout the storm activities Monday and Tuesday. Both bridge decks, in the CMA and salt test sections, appear to be clear to nearly the same extent and both are clearer than their respective connecting roadways. Both decks were probably cold enough to prevent the sticking and build-up of snow.

The CMA section required 18.5 tons of CMA plus 2 tons of salt to achieve complete clearance. Five (5) tons of salt were used on the salt section.

STATE OF MICHIGAN

JAMES J. BLANCHARD, GOVERNOR

DEPARTMENT OF TRANSPORTATION

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JAMES P. PITZ, DIRECTOR

April 8, 1983

Dr. Brian H. Chollar
Materials Technology & Chemistry Div., HNR-40
Federal Highway Administration
Washington, D.C. 20590

Dear Dr. Chollar:

In accordance with your request, I am submitting this progress report concerning our evaluation of CMA during the January-March 1983 quarter. This progress report is merely a summary of a previous Interim Progress Report (February 28, 1983) and storm history submitted on March 28, 1983.

INTERIM REPORT SUMMARY

The first deliveries of CMA arrived at the Grand Ledge Garage on Tuesday, February 8, 1983. Preparation of the spreading vehicle and calibration of the spreader box was completed on Wednesday, February 9, 1983. Guidelines for the field test, application, and reporting procedures were reviewed and discussed with the field supervisor, vehicle operators, and observers.

A trial application of CMA was conducted on Friday, February 11, 1983. The test was performed on a closed section of recently completed I-69 freeway north of Lansing. The objective was to determine if any equipment modification was needed, to observe the spreading pattern and to perform friction tests. No equipment modifications were required and the observed spreading pattern was considered good. The friction tests (ASTM E-274) were made on iced sections of pavement using our Testing and Research Division's two-wheeled tow trailer with ASTM #501 test tire.

Measurements taken on the iced sections, although limited in extent, did allow a suitable friction level analysis. General observation of the melting action of the CMA application as compared to a parallel application of NaCl indicated very similar results.

While handling the CMA material in bulk form, a substantial amount of dust is produced. This was observed while workmen were dumping the material into the bulk stockpile and while loading the spreader box with the front end loader. The dust was considered great enough to require the men handling the material to wear protective dust masks. The dust tends to form a sticky film that adheres to clothing and equipment. In discussions with Mr. Marynowski of SRI International, he indicated the material was produced with a higher than specified fines content.

STORM HISTORY

The March 20 storm started around 6:00 PM, Sunday, and ended Tuesday morning with a total snowfall of over 8 inches. Winds of up to 20 mph caused considerable drifting. An extensive period of warm weather preceded the storm so that pavement temperatures were warm enough to result in considerable sticking and packing of the snow by traffic. Snowfall ended Tuesday morning with blowing and drifting stopping before noon.

CMA and salt were applied on Sunday evening, but neither was effective due to the intensity of the storm. Continuous blading was required until mid-day on Monday to keep the highway open with the snow pack remaining 1 to 2 in. thick during this time. The next applications of CMA and salt were made on Monday at noon but because of continued storm conditions and low temperatures (18°F) neither was effective. CMA was applied again at 3:00 PM and 5:00 PM with no effect.

The snow pack remained over both roadways until Tuesday morning when some melting was observed in both roadways. Sunshine and wind abatement aided subsequent clearing operations. CMA applications were made on Tuesday at 8:45 AM, 10:00 AM, and 10:45 AM with little or no effect on the snow pack.

The pavement began to clear on the salt section soon after the first application and progressed rapidly throughout Tuesday morning. One lane was clear by 11:00 AM and other lanes were breaking up. Snow pack remained over the CMA section until about noon on Tuesday when salt was then applied. Salting was necessary to clear the surface of all snow pack and slush as temperatures near zero were predicted for that night. Both roadways were completely clear and dry by 4:00 PM Tuesday.

The CMA section required 18.5 tons of CMA plus 2 tons of salt to achieve complete clearance. Five (5) tons of salt were used on the salt section.

A minor storm on March 28, 1983 required spot applications of salt and CMA on icy patches on and under bridges at about 6:00 AM. One ton or less of CMA was used since the temperature increased rapidly from about 30°F to 38°F during the day.

Sincerely,

TESTING AND RESEARCH DIVISION

J. H. DeFoe - Supervisor
Soils and Bituminous Mixtures Group

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JAMES P. PITZ, DIRECTOR

October 7, 1983

Dr. Brian H. Chollar
Materials Technology and Chemistry
Division, HNR-40
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Washington, D.C. 20590

Dear Dr. Chollar:

This progress report covers the evaluation period from April through September 1983 and describes our CMA storage trials. Most of the CMA remaining after the winter evaluation tests was stored as shipped, in bags and on pallets, within a salt storage shed. As part of the storage experiment, the bulk stockpile was built up to about the same quantity as would be used for normal winter storm preparation.

On May 11, 1983, moisture samples taken from the bulk stockpile inside the storage shed indicated a moisture content of 7.3 percent. By September 1983, a crust of 2 to 3 inches had formed over the entire pile.

On May 17, 1983, a small outside stockpile of CMA was constructed using seven bags of material placed on a plywood base and covered with canvas. The initial moisture content was 1.9 percent. On June 10, 1983, the canvas was removed from the stockpile. A thick crust had formed over the entire pile. The moisture content of the stockpile below the crust was 5.1 percent at that time. The crust was removed from the pile, several bags of CMA were added, and the pile reshaped and covered with black plastic.

On September 9, 1983, pictures were taken of the stockpile and the residue of the black plastic which had become brittle and disintegrated.

Moisture contents of the CMA at the end of the evaluation period were as follows:

| | |
|---|---|
| "Dry" CMA within the bulk pile | 5.7 percent |
| Crust, over the bulk pile | 32.1 percent |
| Uncovered CMA from outside pile (Previously covered with plastic and now almost all crust) | 38.7 percent |

Even though the moisture within the bulk pile had decreased to some extent (7.3 to 5.7 percent), the formation of a thick crust shows the need for careful storage procedures. Moisture content of material stored in bags within the shed will be measured when ice control activities begin this winter.

Sincerely,

J. H. DeFoe, Supervisor
Soils and Bituminous Mixtures Group

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JAMES P. PITZ, DIRECTOR

January 11, 1984

Dr. Brian H. Chollar
Materials Technology and Chemistry Division, HNR-40
Federal Highway Administration
Washington, D.C. 20590

Dear Mr. Chollar:

This quarterly report describes CMA evaluation applications during the October through December 1983 period. Eleven storms occurred in which CMA was applied. The enclosed table summarizes the storm conditions and an assessment of the effectiveness of CMA as compared with rock salt. The table also shows that 32½ tons of CMA were used while salt usage totaled approximately 11 tons.

Effectiveness of CMA compared to rock salt is indicated in Table 1. The numbers indicating the relative effectiveness, as judged by Maintenance operators and Testing and Research technicians, have the following meaning:

0. No comparison was recorded. This response usually occurred when a small amount of CMA was applied to isolated spots with no corresponding salt application.

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 data obtained during this quarter indicate that CMA does melt ice or snow but its action is, generally, slower and it does not melt as completely as does rock salt under the conditions tested.

Approximately 80 tons of CMA were stored in the original 25 lb bags until November 1983. On November 4, all the remaining bags were opened and the loose CMA material placed within a covered storage shed normally used for rock salt. Moisture content of the CMA, measured immediately after completion of the storage pile, was 2.7%.

Approximately 50 tons of CMA remain for evaluation as of January 1, 1984.

Sincerely,

J. H. DeFoe
Supervisor, Soils & Bituminous Mixtures Unit
Research Laboratory Section

TABLE 1

CMA STORM APPLICATIONS
November and December 1983

| Storm Date | Temperature °F | Storm Conditions | Effectiveness | CMA Applied, Tons |
|---|---|---|---|---|
| 11-11-83 | 32 | Wet snow, windy, warming | 2 | 1 |
| 11-29-83 | 30 | Trace of snow, slight icing in protected areas | 0 | 1 |
| 12-1-83 | 25 | Light snow, glaze of ice in traffic lane | 0 | 1/2 |
| 12-4-83 | 26 | Freezing rain, iced roadway - second application CMA needed on bridge deck | 2 | 2 |
| 12-5-83 | 32 | Continuous heavy snowfall | 3 | 3 |
| 12-6-83 | 22 | Blowing snow. Second application CMA needed | 2 | 6 |
| 12-9-83 | 26 | Continuous heavy snow, snow pack between wheel paths. Three CMA applications needed. | 2 | 9 |
| 12-14-83 | 30 | Light rain, freezing on bridge decks only; Four passes CMA per deck were needed | 2 | 1/2 |
| 12-21-83 | 24 | Thin ice layer on pavement | 3 | 3 |
| 12-22-83 | 22 | Blowing snow sticking to moist pavement | 2 | 6 |
| 12-28-83 | 17 | Heavy snow with some blowing | 3 | 1/2 |