REPORT OF COMMITTEE ON MAINTENANCE

B C TINEY, *Chairman*

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PROGRESS REPORT

ON

TREATMENT OF ICY PAVEMENTS

SYNOPSIS

It has been the practice of highway maintenance engineers among certain northern States to use calcium or sodium chloride for treatment of icy pavements during the winter months These materials are usually added to sand or cinders and the mixture spread upon the travelled surface They serve to lower the freezing point and embed the abrasive particles in the ice, thus rendering the surface non-skid Considerable diversity of opinion, however, has existed concerning the most effective manner in which these salts should be used, whether they damage the surface of concrete pavements, and their relative ability to melt ice This is a progress report on the Maintenance Committee's investigations covering these points

At the 1931 meeting of the Highway Research Board,[1] the Maintenance Committee presented suggestions for the treatment of icy pavements based upon the methods in use by the various state highway departments

The embedment of abrasive material, such as sand or cinders, in the ice by means of treatment with calcium or sodium chloride was suggested as the most effective means of securing traction for vehicles The complete removal of ice from concrete pavements by applications of chloride was not recommended

The fact that sand, stock piled for winter use may, to a large extent be maintained in an unfrozen condition by treatment with comparatively small amounts of chloride is also an important feature of this method

Owing to the fact that instances have been observed of disintegration or pitting of the concrete where the ice had been melted by the application of chloride and abrasive material, the committee felt that studies should be made to determine the extent, if any, of deleterious action due to the treatment, although it was realized that such effects might also be caused by traffic passing over an accumulation of abrasive material, or by repeated freezing and thawing caused by the melting of the ice with subsequent freezing

[1] Report of Committee on Maintenance, Eleventh Annual Proceedings, Highway Research Board, page 364

It was therefore arranged to carry on investigations in the laboratories of the Michigan Highway Department, and of the District of Columbia, on the following points

1 The relative melting power of sodium and calcium chloride at various temperatures

2 The minimum amount of each salt necessary to embed abrasive material in ice at various low temperatures

3 The effect of sodium chloride and calcium chloride on the surface of concrete when the concrete is subjected to repeated freezings and thawings

4 The use of coverings to seal the concrete so that the salt solutions can not penetrate

Concrete blocks of approximately 100 sq in area were prepared with raised edges so that solutions of chlorides could be held on the surface of the specimen Series of different consistencies of concrete, of different degrees of finish, using various concentrations of solution and placed in various degrees of low temperatures were included in the tests

The program of tests as carried out by the laboratory of the District of Columbia, included some specimens covered with a solution of sodium silicate and some covered with asphalt previous to the application of chloride solutions, also specimens were tested on which a calcium chloride solution of such concentration that freezing did not occur was applied

The tests were to be made upon specimens aged 30 days, six months and one year At this time the 30 day and six months' specimens have been tested Various interesting indications have been noted as the result of these early tests and are summarized in this progress report A final and complete report of the investigations, with the committee's findings will be made after the completion of the one year tests

RESULTS FROM TESTS ON SPECIMENS ONE MONTH AND SIX MONTHS OLD

1 Data from these tests show the eutectic point for sodium chloride to be −6°F The freezing of dilute solutions of sodium chloride will result only in the formation of ice crystals so long as the freezing temperature is maintained above −6°F If a freezing temperature below −6°F is used the whole mixture of ice and salt crystals will solidify since no solution can exist below the eutectic point As the eutectic point for $CaCl_2$ is −58 5°F the solutions of $CaCl_2$ would be effective, under general weather conditions for melting ice without crystallization of the $CaCl_2$

2 At temperatures above approximately 0°F sodium chloride has the greater melting power and therefore the greater potential sand embedment property However, below −6 5°F, the eutectic point of sodium chloride, this salt has no melting or sand embedment power,

whereas calcium chloride continues to be active down to a temperature of −58.5°F.

3. Both sodium and calcium chlorides in the concentrations employed adversely affected the mortar bond to a marked degree.

4. The sodium chloride affected the mortar bond more than calcium chloride since the specimens immersed in solutions of the former de-

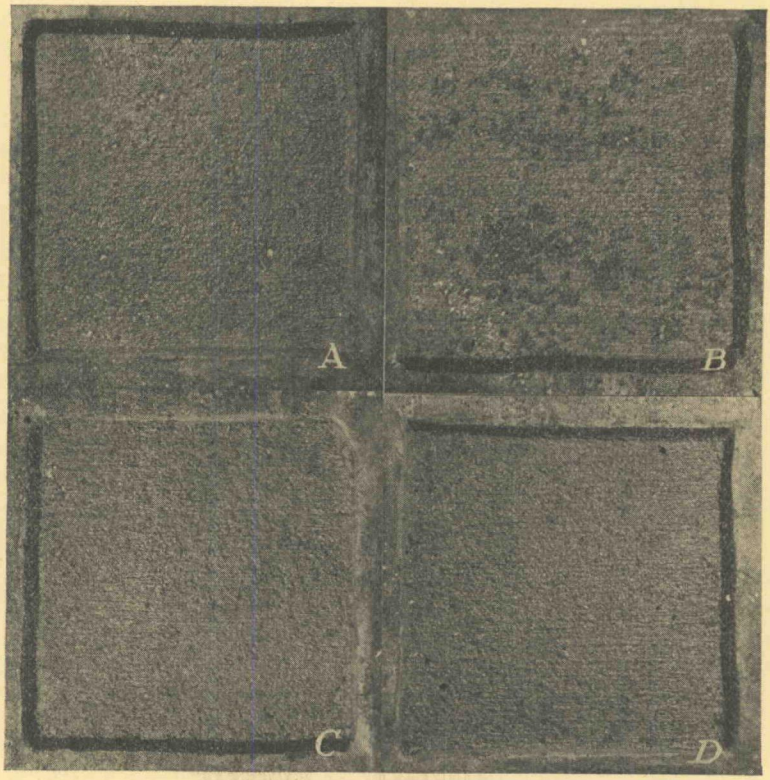

Figure 1. Effects of Calcium Chloride and Sodium Chloride Treatments on Surface of Concrete

A. Four per cent calcium chloride on plain concrete (slight disintegration).
B. Four per cent sodium chloride on plain concrete (slight disintegration).
C. Eight per cent calcium chloride on plain concrete (slight disintegration).
D. Eight per cent sodium chloride on plain concrete (slight disintegration).

veloped large longitudinal cracks with minor spider-web cracks, whereas specimens of the latter only developed surface scaling. This cracking was more serious since in many cases the entire cylinder disintegrated.

5. Both sodium and calcium chlorides applied to the surface of concrete increased the pitting or scaling occurring from repeated freezing and thawing of the concrete. The sodium chloride was somewhat more detrimental than the calcium chloride.

6. Calcium chloride applied to the concrete surface did not cause deterioration of the surface concrete unless the specimen was subjected to repeated freezing and thawing; however, the presence of calcium chloride accelerated the deteriorating action of repeated freezing and thawings.

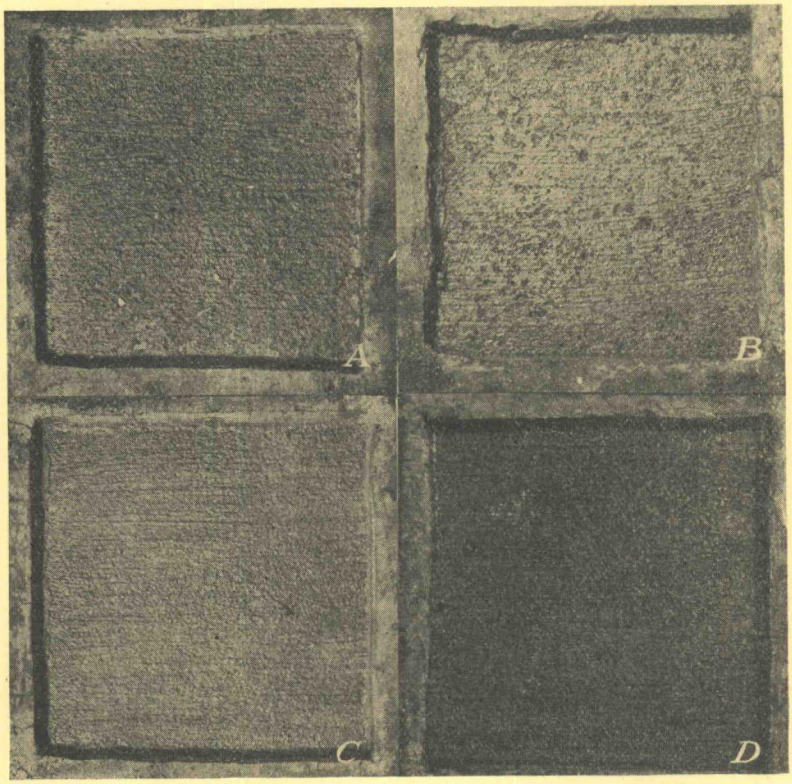

Figure 2. Effects of Treatments with Chlorides and Boiling Water upon Concrete Surface

A. Twelve per cent calcium chloride on plain concrete (slight disintegration).
B. Twelve per cent sodium chloride on plain concrete (slight disintegration).
C. Thirty per cent calcium chloride on plain concrete (no disintegration).
D. Block from which an ice coating (plain water) was removed by the application of boiling water (slight disintegration).

7. Cores taken from existing pavements were alternately immersed in chloride solutions and dried at room temperature, in the Michigan laboratory, without showing scaling or disintegration after 60 cycles.

8. The coating of the concrete with oil, asphalt, or sodium silicate previous to making the tests did not prove of value in protecting the concrete against pitting or scaling of the surface.

9. One of the most important factors controlling the severity of

pitting and scaling as shown by these tests is the amount of chert, shale, or soft stone that exists near the surface of the concrete It is evident from a detailed study of the specimens the presence of such material near the surface almost invariably resulted in deep pitting and removal of surface mortar.

10 The results of this investigation prove the importance of prohibiting the use of aggregates, for concrete pavements, which contain appreciable percentages of chert, shale, or soft stone

Note It should be noted that the results shown from these tests were due to 30 cycles of freezing and thawing and the solutions of chlorides

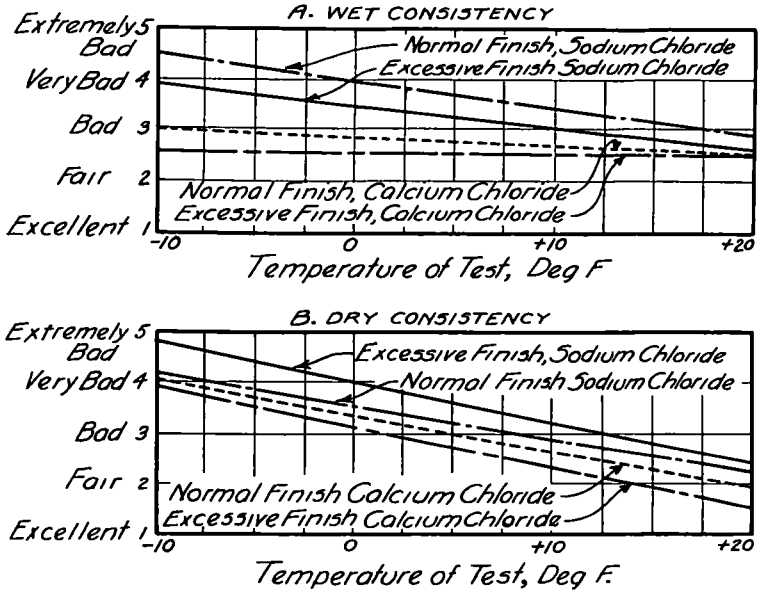

Figure 3. Surface Condition Rating of Specimens at Conclusion of Test. Averages of Three Application Rates

were the strongest which might be used In practice considerable chloride would be absorbed or adsorbed by the abrasive and much of it would be dissipated by traffic Such results as are shown by these tests might be expected only where concentrations of the solutions and abrasives were permitted to remain on the surface of the concrete and where conditions were such that repeated freezing and thawing would occur The tests do indicate, however, the importance of the proper supervision and care which should be exercised in following the method recommended below for treatment for icy pavements

RECOMMENDATIONS AS A RESULT OF TESTS REPORTED

Inasmuch as the use of calcium chloride or sodium chloride for the treatment of icy pavements has been shown to accelerate and increase

the detrimental effect on the surface of concrete when such concrete is subjected to freezing and thawing it is recommended that when treated ice melts attention should be given to be sure the slush which collects on the pavement as at bottoms of hills, etc is removed, otherwise the subsequent freezing may cause pitting or scaling of the concrete surface

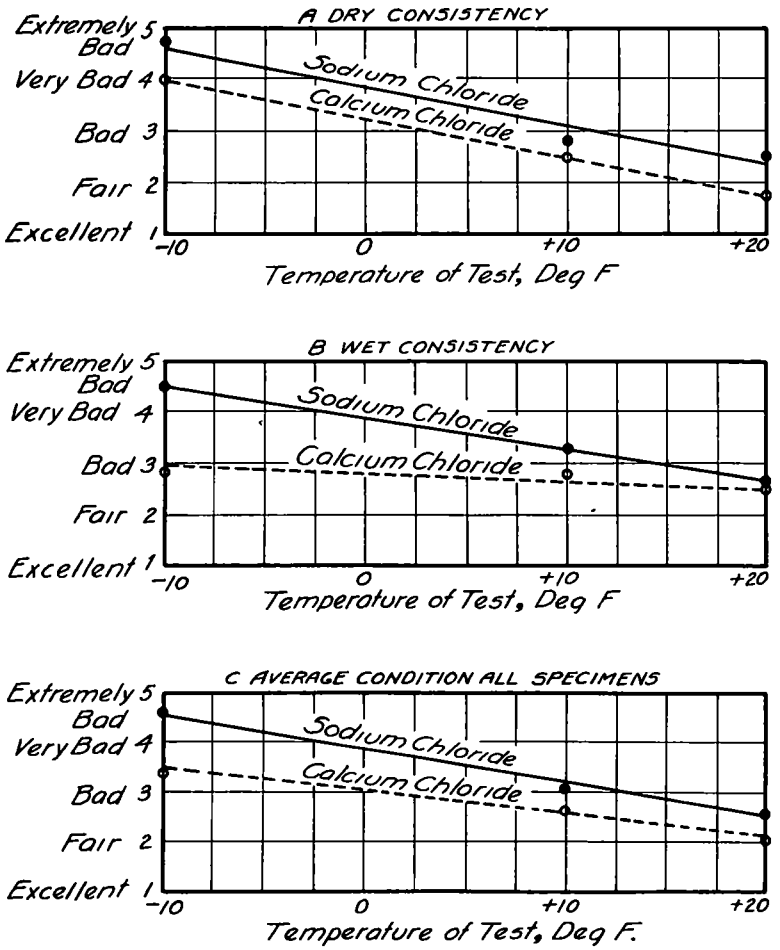

Figure 4. Surface Condition Rating of Specimens at Conclusion of Test. Averages of Three Application Rates, Two Finishes

It is most important that all accumulations of abrasive material be removed from the pavement surface as soon as the ice melts

The Committee is of the opinion that if its recommendations, as offered last year, are followed, there will be very little, if any deterioration of the pavement surface

DISCUSSION

ON

TREATMENT OF ICY PAVEMENTS

DR WM STERICKER (*Philadelphia Quartz Company*) I would like to inquire what concentration of sodium silicate solution was used and the age of the concrete at the time of applying the sodium silicate

MR PAUL W DOWNEY (*Division of Materials, District of Columbia*) A 40 per cent solution of sodium silicate was used and applied on the surface after the concrete had attained an age of six months The surfaces of the specimens were thoroughly brushed before applying the protective coating so as to insure satisfactory bond with the concrete

DR STERICKER I believe more satisfactory results would have been secured had a less concentrated solution been used, approximately one part of sodium silicate to four parts of water A solution of this concentration would more easily penetrate the concrete surface

INVESTIGATION OF MUD JACK SOILS

BY A. C BENKELMAN, *Research Engineer*
Michigan State Highway Department

SYNOPSIS

Success in raising pavement slabs permanently by the mud-jack process depends to a large degree upon the characteristics of the materials used The effects of texture, amount of organic material present, amount of cement used and amount of water needed for workability upon the shrinkage properties of the soil appear to be the significant factors Two hundred and fifty samples of soils used with mud-jacks of both the piston and compressed air type were analyzed and the range in satisfactory grading for each type determined In general, coarser soil can be used with the compressed air jack than with the piston jack From a series of laboratory tests the effects of texture, organic content, water content and cement content upon shrinkage, workability and stability were studied, resulting in diagrams showing the relation between amount of cement, organic content and shrinkage It appears to be desirable to use as coarse a soil containing as little organic material as possible Unless the amount of organic material is limited, the use of the customary small amount of cement (5 per cent) will have little effect in reducing shrinkage since high organic content requires an excessive amount of water for workability

When the Michigan State Highway Department purchased a Poulter Pavement Mud Jack in 1931, very little definite information was available concerning the manner in which this machine should be operated to produce the best results. There were questions as to what type of