# EVALUATION OF SODIUM CHLORIDE FOR STABILIZING AN AGGREGATE BASE COURSE

(M 28 East of Bruce Crossing, Project No. 00955A)

MICHIGAN DEPARTMENT OF STATE HIGHWAYS AND TRANSPORTATION

TESTING AND RESEARCH DIVISION
RESEARCH LABORATORY SECTION

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Research Laboratory Section
Testing and Research Division
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Michigan Department of Transportation
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In an earlier project (1) the effects of adding different levels of sodium chloride in the form of rock salt (6, 12, and 18 lb/ton of aggregate) to base course aggregates containing various percentages of minus 200 material (5, 9, and 12 percent) were studied in an effort to determine whether the addition of rock salt would allow use of aggregates containing a higher than specified quantity of minus 200 particles. Results of that study, which extended over an 11-year period, showed that although rock salt was a good construction aid for obtaining compaction and resulted in satisfactory base construction, no long-term benefits were obtained by the use of the admixture. Based on statistically meaningful rut depth measurements obtained over the life of the project, the most satisfactory test sections were generally those with the lowest minus 200 and the lowest (6 lb/ton) salt content. With the exception of one section, a definite detrimental trend was indicated when the salt treatment exceeded 12 lb/ton. With the exception of the highest salt and minus 200 combination, however, all of the sections performed satisfactorily over the test period, which led to the conclusion that Michigan's specifications allowing 6 lb of salt per ton of aggregate were sound, but that in cases where the minus 200 material exceeded the normally specified 7 percent maximum that up to 12 lb/ton salt could be added. This additional amount could also compensate for possible lack of uniform mixing during normal field construction procedures. Satisfactory bases using a 12 lb/ton salt treatment have been constructed on several jobs in the Upper Peninsula where up to 10 percent minus 200 material was permitted.

Subsequent to our findings concerning the questionable use of higher quantities of salt in aggregate mixtures, the Department was approached by representatives of the salt producers who felt that we had not gone far enough when adding 18 lb of salt per ton and suggested that at least 40 lb of salt per ton of aggregate should be used if a significant benefit were to be attained.

At a meeting between the Testing and Research and Construction Divisions it was decided that the claims of the salt producers could be checked easily and economically during proposed construction in the Upper Peninsula of any project for which the 12-lb salt treatment had already been scheduled. It was also decided to include untreated aggregate sections in the study, so that three levels of treatment could be compared: 1) no salt treatment; 2) the scheduled 12 lb/ton; and, 3) the producer recommended 40 lb/ton.

The project in this form was approved and a proposal prepared, dated March 1972. The test areas formed a part of the M 28 construction just east of Bruce Crossing (Project No. 66023-00955A).

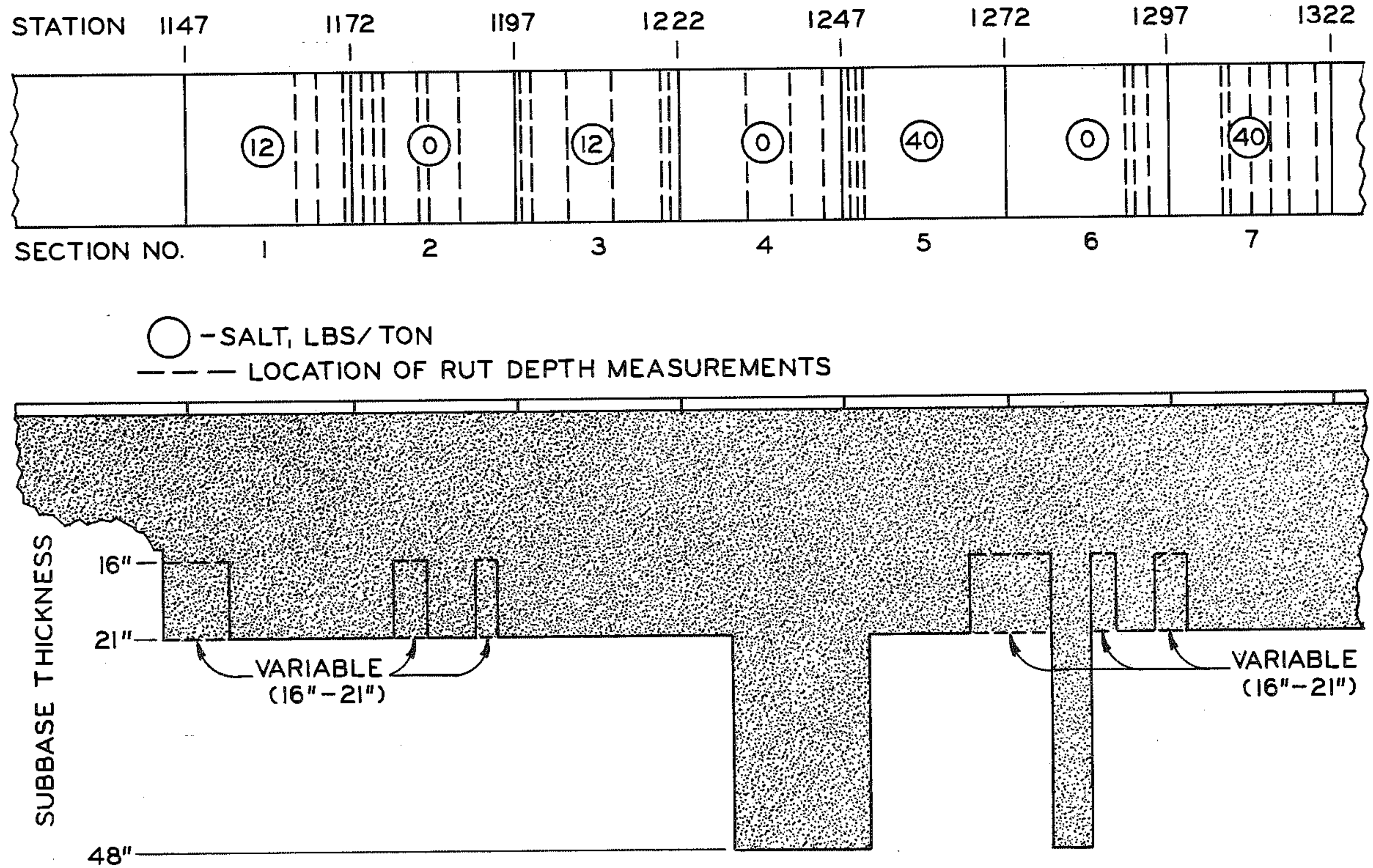



Figure 1. Schematic layout of test area.

Work on the project was performed under the immediate supervision of J. H. DeFoe, assisted by M. J. Tiedt and G. F. Sweeney.

## Construction and Evaluation of the Test Sections

A schematic layout of the test sections is shown in Figure 1. The test area consists of seven 2,500-ft long sections in which salt contents varied from 0 to 40 lb/ton of aggregate, as shown. This figure also indicates the subgrade profile beneath the test sections. The bases and selected subbases were both of a 22A aggregate, modified to permit up to 10 percent minus 200 material and both were included in the salt treatments.

Rock salt was added to the aggregate in measured quantities from a small hopper and the two mixed in a pugmill before loading into trucks for placement (Fig. 2). Attempts were made to maintain a moisture content of approximately 6 percent during mixing. The treated aggregates were applied, spread and compacted following normal construction procedures. Densities were measured with the Seaman nuclear gage. No problems were encountered due to the use of salt.

As found in previous studies (1) and shown in Figure 3, the higher salt treatments resulted in higher maximum design densities. In-place densities, determined after construction traffic had been applied, also showed higher densities with higher salt treatment.

Typical of the compacted salt-treated areas are the general and close-up views of a 12-lb section shown in Figure 4. Evaporated salt solutions often produced hard white crystals of salt at the surface of the treated areas. All bases were primed and surfaced with an approximately 2-1/2-in. thick bituminous concrete wearing course.

At completion of the asphalt surfacing, in October 1972, rut depth measurements at selected stations in each test were made using techniques described in Ref. (1). Measurements were made at each wheel-track in both the north and southbound lanes. Yearly rut depth measurements have continued through 1977.

It was originally planned to obtain periodic densities of the different bases but this proved to be too cumbersome for the information that might be developed. To measure base density it is necessary to core, or otherwise remove the asphalt surfacing, in order to reach the area to be tested. Use of the Troxler gage in the penetration mode through a cored hole, did not give consistent data and was discontinued. To remove larger areas of

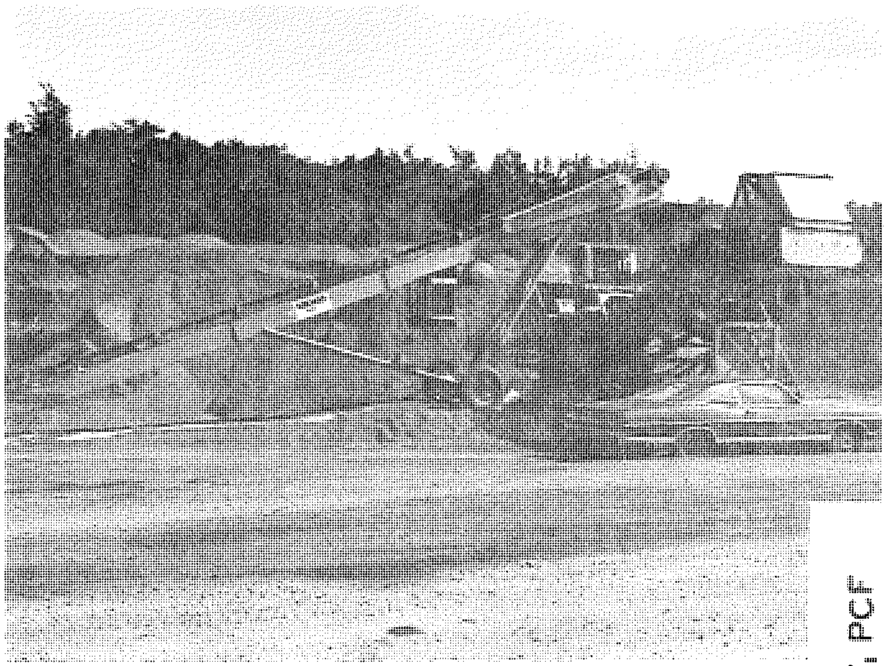
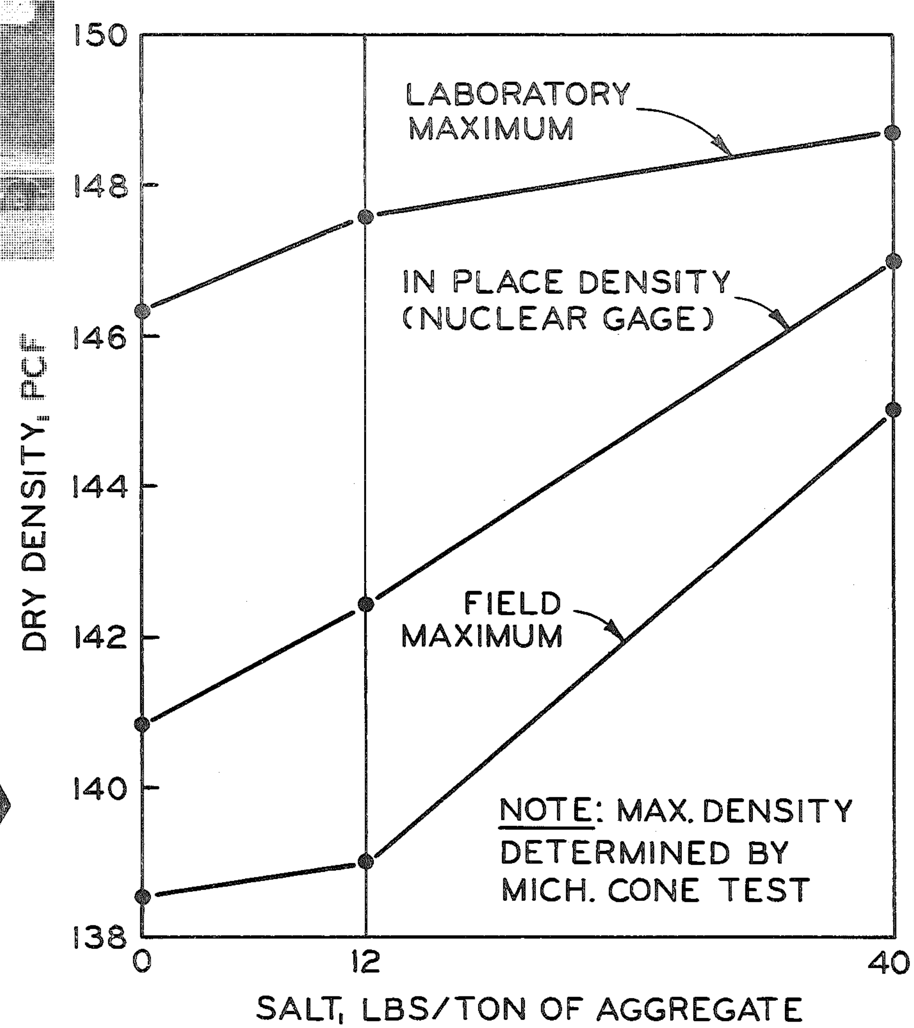


Figure 2. Plant for mixing salt-treated aggregates.

Figure 3. Effect of salt content on field and laboratory density values.



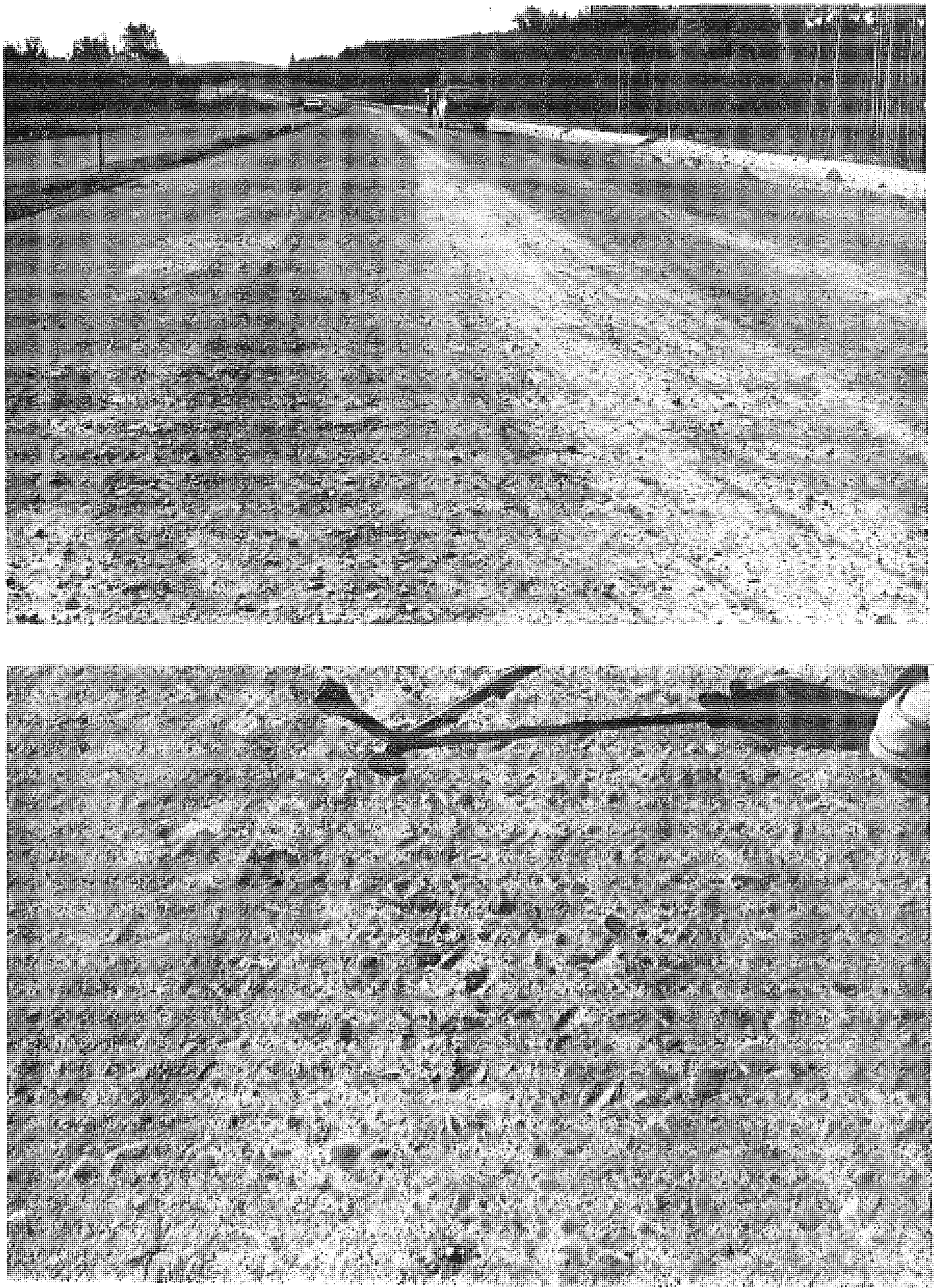


Figure 4. Appearance of salt-treated sections after compaction, 12-lb section.


Figure 5. Equipment used for coring.

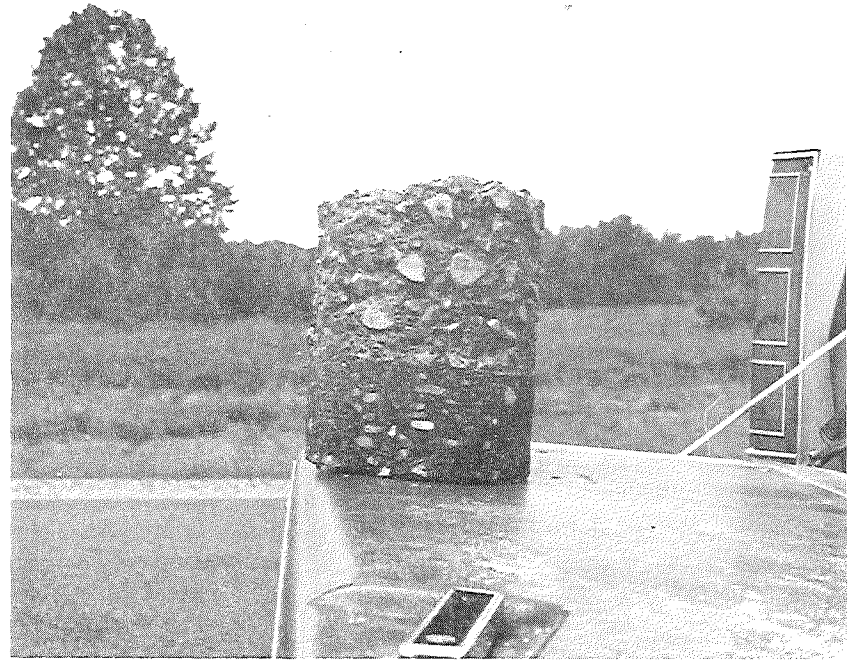


Figure 6. Best core obtained (40-lb treatment).

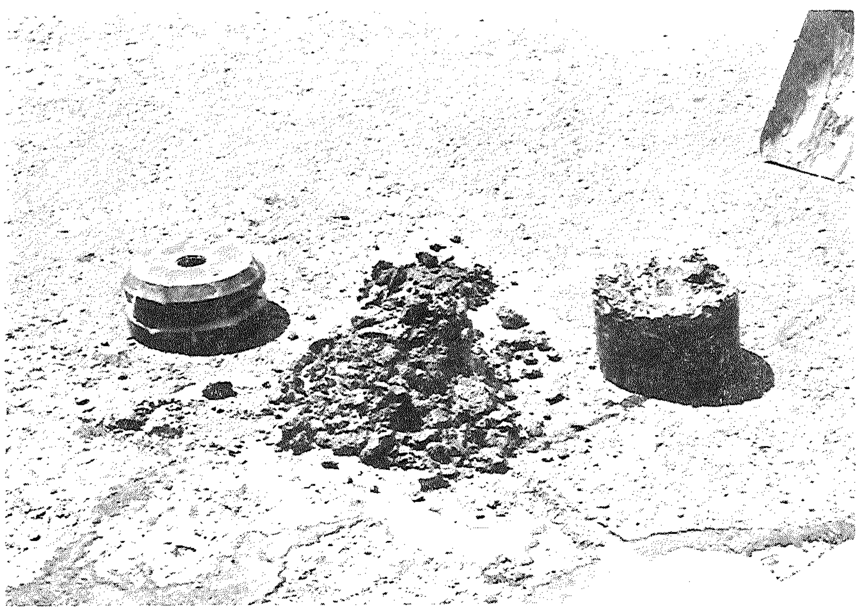


Figure 7. Loose base material typical of coring attempts.

surfacing, to allow placing the gage on the base surface, was time-consuming and damaging to the roadway surfacing. Also, previous studies on the Newaygo project (1) showed no significant trends of density change after the first year of construction nor a correlation between density differences and pavement performance. Instead, as on the Newaygo project, it was decided to evaluate the different salt treatments by means of rut depth measurements and periodic inspection, at least until such time as any significant changes in the different sections became apparent.

Attempts were made to core the bases during the summer following construction but this attempt was not too successful. The same coring rig as used on the Newaygo project was furnished and operated by personnel of the Salt Institute in cooperation with the Morton Salt Co. (Fig. 5). The only core of reasonable size that could be obtained was from the 40-lb area (Fig. 6). Attempts to take cores from other test sections resulted in obtaining little more than the bituminous surfacing (Fig. 7).

Figure 8 shows the results of rut depth measurements over a five-year period. The values represent averages of the four wheel-track rutting measurements made at the locations shown in Figure 1, and averaged for each level of salt treatment. As in the Newaygo project, the greatest rutting was in the higher salt-treated areas, and the least in the 12-lb treatment. The rut depth values for the different treatments progressed in a similar manner with time and the relative effects of the treatments continued about the same. Future measurements, at extended time intervals, will be made to see if this relationship changes. It should be noted that the differences in the treatments, so far, are not of practical significance. This has been verified by visual inspection and checking the riding qualities of the sections. Figure 9 shows the typical appearance of surface conditions for each of the test sections as of July 1977.

## Laboratory Testing

Samples from all of the test sections were bagged and submitted to the laboratory for various tests. Information developed from these tests was supplemental to the project and the results were not used in construction or the field evaluation of the test sections.

As shown in Figure 3, maximum densities of the various treatments as obtained in the laboratory were higher than the corresponding field maximum and the in-place densities, but the increase in density—due to the salt addition—was not as great. The Michigan Cone Test was used for the laboratory and field maximum density determinations.

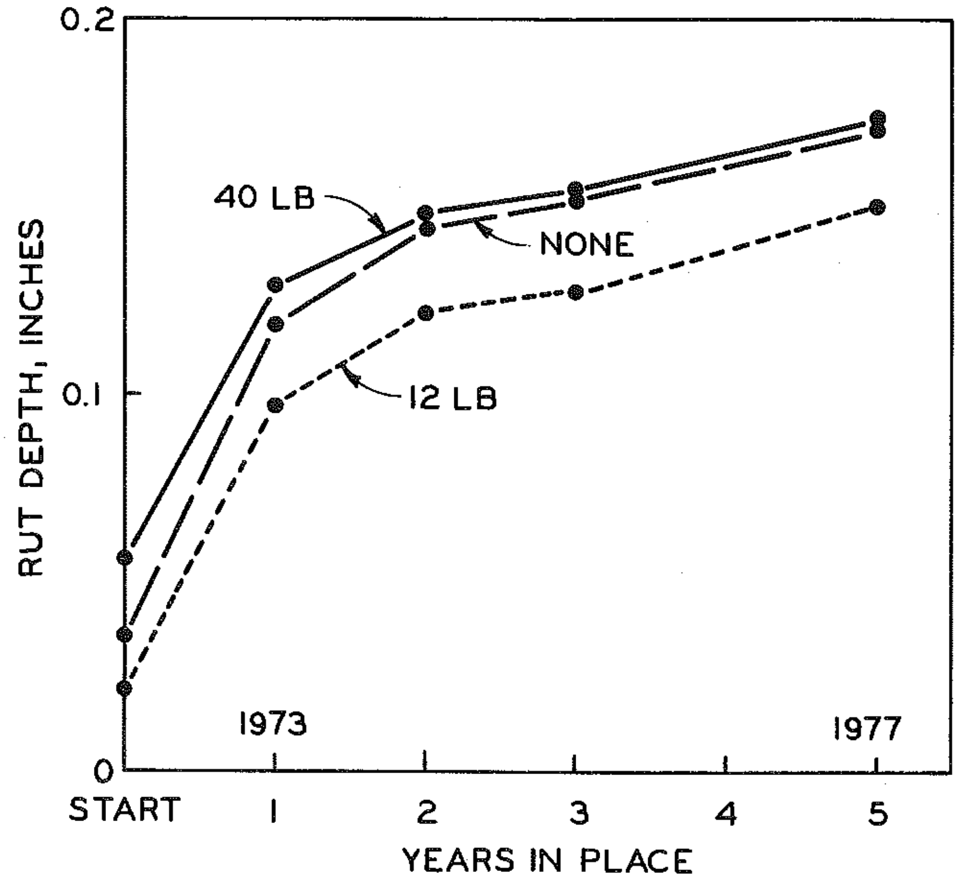
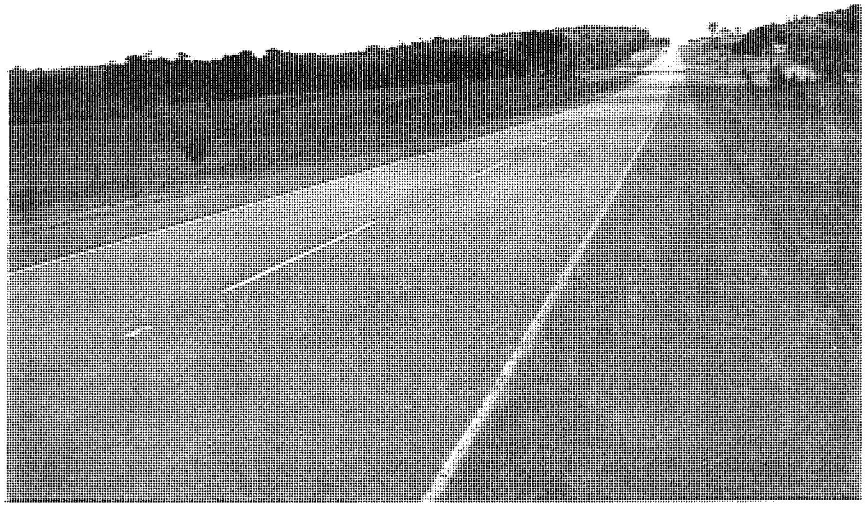


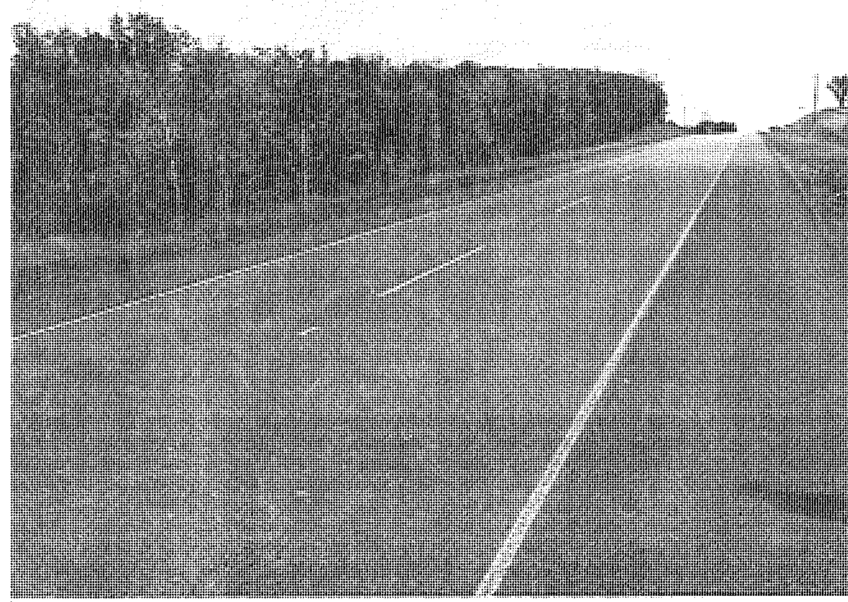

Figure 8. Rut depth values over a five-year period for each level of salt treatment.

A series of tests were run to determine the elastic modulus of the various salt treated materials and to determine the effect of long-term curing on the samples. Because the modulus values were influenced by sample density the test specimens were molded at the same density for each salt treatment using two levels of density to approximate the higher and lower maximum densities obtained for field construction control (144.5 pcf and 138.5 pcf). In addition, modulus determinations were made for samples compacted to average in-place densities for the various salt treated test sections. Results of these tests are summarized in Figure 10. In general, these data show no particular trend to indicate a significant difference between the different levels of salt treatment, which verifies the field test findings to date. The only exception is the case where the samples, compacted at 146 pcf, were cured for one year prior to testing. These samples were sealed with paraffin wax immediately after molding. This test indicated that modulus values were much higher for the cured samples than for the uncured, but that this benefit decreased with increased salt content. The reason for this is not known but could be due to base exchange between the sodium in the salt and the clay mineral fraction of the aggregate which could cause dispersion of the clay and prevent bonding with the aggregate. Additional tests would be required to properly evaluate such factors.

Laboratory tests to determine the salt content of the treated areas showed, as in previous studies, that there was considerable variation in individual test sites throughout a given section. Much of this could be due to sampling error as well as variation in field mixing. Overall averages were close to design values in the 12-lb sections, but the 40-lb areas averaged approximately 36 lb/ton. These variations should not affect the relative field evaluation of the project.



◀ Untreated base.



▲ 12-lb salt-treatment

◀ 40-lb salt-treatment.

Figure 9. Appearance of the test sections, July 1977.

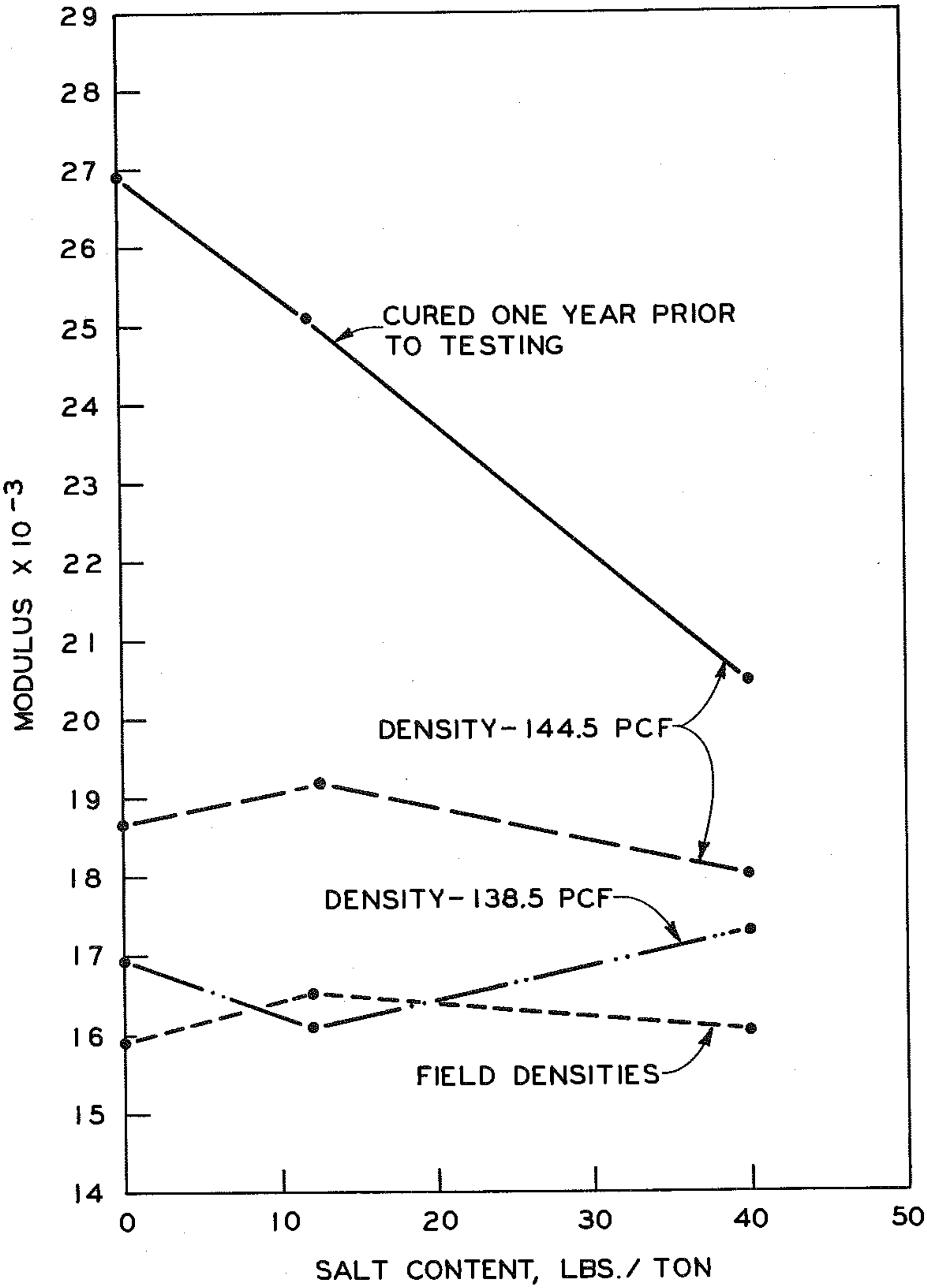



Figure 10. Effect of salt content on modulus of samples under different conditions of test.

## Conclusions

Based on testing and the performance of the test sections over a five-year period, the following conclusions have been reached.

1) All of the test sections are performing in a satisfactory manner. There is a small difference in rut depth measurement in favor of the 12-lb salt treatment which, although statistically significant, is not of practical significance.

2) No problems were encountered with the salt applications as compared with normal construction procedures.

3) Higher densities were obtained with the salt treatments both in the laboratory and in the field.

4) Laboratory determinations of the resilient modulus of samples showed no significant trend of results between the 0, 12, and 40-lb treatments.

5) Some variations from design salt treatments were found at various locations within the test areas, as determined by laboratory tests of 500-g samples. Such variations should not be detrimental to the overall evaluation of the project.

6) If salt is to be used as a construction-aid for base compaction it appears that the present specification value of 6 lb of salt per ton of aggregate is satisfactory. However, because of mixing problems, and the relatively low cost of rock salt, a value between 6 and 12 lb/ton should be acceptable. More than this amount appears to offer no advantage and might be detrimental.

7) The condition of the test sections should be observed and measured on a limited basis for several more years to determine possible future changes in the test sections.

## REFERENCES

1. Mainfort, R. C., "Stabilization of Base Course Aggregates with Rock Salt," MDOT Research Report No. R-685, January 1969.