PROGRESS IN USE OF SODIUM CHLORIDE IN ROAD STABILIZATION

By B. R. Downey, *Maintenance Engineer, Michigan State Highway Department*
R. M. Rowat, *Canadian Industries, Ltd.*
L. J. Ettinger, Jr., *International Salt Co., Inc.*

Arranged by R. W. Crum

SYNOPSIS

An interesting trend in the use of salt for stabilization in Canada was reported by Mr. Rowat. In 1936, the ratio of the quantity of salt used for surface treatment to that used for base stabilization was 4 to 1. In 1939 the ratio had changed to 1 to 14, and the total consumption had increased 15 times in the same period. The central mixing plant was the method preferred for preparation of the material. Salt was used at about 25 lbs. per cu. yd., and costs were about $0.54 per cu. yd. including all cost items except gravel costs.

Mr. Ettinger reports that a cost of $70 per mi. for salt for the first year is to be expected with cost of half that for subsequent years.

Mr. Downey describes the experiments of the Maintenance Division of the Michigan State Highway Department with a type of shallow surface stabilization using a simple road mix procedure.

Rowat: The report of the Subcommittee on Treatment with Sodium Chloride of the Highway Research Board which was published early in 1936 as Part 5 of the Second Progress Report of the Project Committee on Stabilized Soil Road Surfaces provided answers to most of the questions implied in the single one "Will it Work?" It covered the how and the how much, the why, the where and the when.

The economic angle to the use of salt for road-stabilization was not covered by this report.

The 1936 report, however, showed that the design essentials for stabilized soil mixtures when using sodium chloride are similar to those with other chemical admixtures for soil densification, in that design depends upon the proper proportioning of soils, aggregates and admixture. There have to my knowledge been no developments since the publication of that report to alter this conclusion. The modifications in design of stabilized soil mixtures which follow from the purpose for which the materials are to be used, i. e.—base or surface course—apply with equal force when salt is used as when some other chemical is employed.

The use of salt for road construction purposes in Canada has grown steadily since 1934.

One very interesting fact in this growth is that the purposes for which salt is used are changing. Originally, salt stabilization was used entirely in the construction of low cost secondary surfaces. In this use the high degree of compaction secured in the presence of salt, the retention of this compaction under changing external conditions and the increased resistance to frost damage, in some cases amounting almost to immunity, drew attention to the probable value of salt as a stabilizing agent for base courses under permanent or semi-permanent tops, and during the last three years salt base-stabilization has become an important practice.

As an indication of the trend the following may be interesting. In 1936, the ratio of salt consumed in surface stabilization in Canada to that used in base stabilization was 4 to 1. In 1939, this ratio had changed 1 to 14.

Several factors appear to be involved in this swing. The importance of base courses to the service lives of roads is more generally appreciated than was the case a few years ago and planned stage construction is becoming more and more a common practice. Add to these that

frost action is one of the major causes of road damage in our climate, and that salt stabilized mats have in practice appeared to have definite resistance thereto, and the present trend is fairly well explained.

Ettinger: Stabilization fits well into the building of higher type surfaces. The stabilized roads can be held over for one or several years until such time as funds are available for the construction of higher types of surfaces. When such surfaces are placed on stabilized bases, they will be more durable, better roads than if they had been placed on unstabilized base material.

DESIGN

Rowat: The mixed aggregate used in the construction of stabilized bases in Quebec province, conforms to the following requirements:

Liquid limit .....under 25
Plasticity index 3-5
Centrifuge moisture equivalent.....under 20
Fraction passing the 200 mesh sieve not to exceed one half of the 40 mesh fraction.

Salt is used at the rate of 25 lb. per cu. yd. of aggregate. Both rock salt from Nova Scotia and evaporated fine salt from Ontario are used, the former in the east and the latter in the west of the province. Similar results have been obtained with both types of salt.

The application of bituminous tops to salt stabilized bases has in some cases been delayed until several months after the base is laid, and in other cases the asphalt surface has been placed with a seasoning period of only a few days. In the first case, the salt stabilized surface has served very satisfactorily as a wearing course during the interval.

As a general principle, we favor the longer seasoning period as affording an opportunity to correct local defects in the stabilization, but so far as present experience goes, the shorter seasoning period appears entirely satisfactory. It is, of course, too early to reach any definite verdict.

In the province of Nova Scotia an innovation in highway construction methods involving the use of salt, is directed towards the control of frost action and has now been practiced for two successive seasons.

The process consists in treating the sub-base course with rock salt at the approximate rate of 20 tons per mile of 20 ft. road. In special cases this may even be doubled. This treatment which undoubtedly increases the degree of compaction obtainable in the sub-base, and thus increases its bearing capacity, is based on the following considerations:

(1) That frost heaves usually originate in the sub-base course.
(2) That winter temperatures in the sub-base course, while below 32°F, rarely fall below 10-15°F.
(3) That it is the soil moisture, and not the soil itself which freezes.
(4) That the freezing point of the soil moisture in the sub-base can be reduced below the normal winter temperature range by treatment of this course with sufficient salt.

This plan of sub-base treatment has been applied on practically all new construction in the Nova Scotia provincial highway system during the past two years, and appears to be effective.

The experimental work of Mr. A. L. Pidous at McGill University in 1936 showed that 2.5 per cent salt will protect clay soils having a moisture content of 25 per cent, based on dry soil weight, against frost down to a temperature of 10°F, and the present work in Nova Scotia represents the practical field application of this finding.

Ettinger: In a County in Central New York State roads are built in a two-year stage. The grading, drainage and base courses are put down during the first summer. The base courses are built of either run of bank gravels or limestone aggregate bound with limestone dust in a

way similar to waterbound construction. Frequently the stone aggregate is bound with a mixture of limestone screenings and shoulder binder. In all cases, the materials are properly graded and the soil binders are of a quality to insure a satisfactory stable mixture.

Salt is placed in all of these bases generally in amounts of 2½ to 3 lb. per sq. yd. Care is taken to compact the bases when there is sufficient moisture to bind the stabilized materials tight. These bases will then serve as a wearing course for the remainder of the summer, and all of the following summer. During the third summer after completion, the bases will receive a bituminous top. From the time of completion of the salt base, until the bituminous surface is laid, two years hence, no salt is added and in most cases little if any machine maintenance is needed. The original, set up by the salt treatment, produces a hard, rugged surface which resists wear and weather. In many cases it was not even necessary to machine the base course surfaces prior to laying the bituminous pavement.

Downey: The Maintenance Division of the Michigan State Highway Department started experimenting this year (1939) with a type of shallow or surface stabilization using rock salt as an admixture to bind the loose material to the surface of gravel roads on the State system in Livingston County. On the work done to date the procedure has been extremely simple requiring a minimum of new material and equipment.

The loose gravel on the shoulders and in the ditches was collected and windrowed by means of a small shoulder maintainer. The quantity of material was estimated and sufficient soil binder was added to raise the quantity passing No. 200 sieve in the soil aggregate mixture to approximately 16 per cent. Rock salt was then added to the pile in quantities varying from two to four tons to the mile depending upon the quantity of gravel on hand. The materials were mixed dry until the clay was pulverized and thoroughly mixed through the gravel, this work being done with a shoulder maintainer to prevent material getting out on the traveled road.

The roadway was then wet down until it was soft enough to remove all holes and chatter bumps by scraping with an under truck blade and the material accumulated by this operation was pushed out to the shoulders to the dry mix. The entire pile was then brought in by means of under truck blades in successive layers until all the material was spread across the road. The blade bringing in the material was under the sprinkler truck so water was continuously added keeping the mix wet throughout the spreading. Another blade was used to shape the road so it would be smooth and have the proper crown.

When the material was all on the road it was left to traffic until it had hardened, usually a period of about six hours, after which the blade was put over the section to remove any loose bits of gravel and the whole thing was wet down again. This brought about a sealing of the surface which was hard, smooth and tight.

The road was used until it showed a tendency to ravel or get dusty, which time varied depending on the weather, from ten days to three weeks, when an application of about two tons of calcium chloride to the mile was made. On the heavier traveled sections successive applications of calcium chloride had to be made during the dry part of the summer so that on US-23 a total of six tons per mile was used, but on M-36 in the same county which was not completed until mid-July two tons of calcium has been used over the greater portion of the road.

These roads remained smooth and did not materially soften during or after rains, failing to show any tendency to rut or get soupy when wet. The throw of clay so often seen on gravel roads during rains was also missing. It is this ability to stay put and hold shape that makes this work

look attractive. Had the salt been placed deeper the benefits might have been more lasting; that is, the seal might have held for a longer period. In some cases so little gravel was on hand that the total layer of material was not more than one-half inch. This varied up to an inch and a half. In one case where a highly plastic clay was used it was found that the road was slippery after the first rain. Sand was added to this section while it was wet and the surface absorbed it and the condition did not occur again. In this way it was found that even if an error had been made in adding clay it might be corrected and the road retain its advantages of not softening.

The greatest difficulty encountered was trying to work the clay into a pulverized condition during the spring. As a remedy for this, clay is being dug from the banks and stock piled for a season of curing during the winter to facilitate pulverizing and mixing in the early spring.

The placing or laying of the material can be handled very rapidly. Two sprinkler trucks with blades and three inch pumps, and another truck with blade can place four miles per day. The cost of mixing the clay and digging the clay from the bank, of course, varies greatly depending on the length of haul and the season of the year.

It appears that by adding the salt early in the spring it will be possible to get it to a greater depth at little or no extra cost. At this time three or four tons to the mile would be added and the benefits would be expected to last over a longer period helping to keep the road hard enough to reduce damage from spring breaks.

The roads on which this method was tried are all in good condition at present, having remained hard and practically dustless through the fall season.

The construction division has gone ahead with their program of building bases for black top on several projects and rock salt and other chemical admixtures were used in the stabilized mix. This is all plant mix work and is closely supervised as to content of all materials and proper plasticity. However, on maintenance work in spite of the fact that it has not been possible to get such accurate control in the field, good roads have resulted.

Rowat: The central plant-mix method has been followed on all projects in Quebec. Potential sources of clay and gravel are sampled and tested by members of the central laboratory staff, and their recommendations determine the choice and the proportioning of materials. Control is exercised through appropriate field tests at the central plant.

Salt-stabilization practice in Manitoba has followed similar lines except that the salt is used in the form of brine hauled in tank trucks from the salt works at Neepawa, adjacent to the projects. In our opinion, road-mix methods are becoming obsolete.

MAINTENANCE

Ettinger: On an average, a salt road properly constructed and of good materials, requires one or two machine maintenances a year, generally in early spring, and possibly again in the fall. They also require on the average one application of one pound of salt per square yard, every spring at the time of the spring maintenance. Salt added each spring keeps these roads in excellent condition.

COSTS

Rowat: The cost of stabilization is considered to be the sum of expenditures for clay, salt, spreading and shaping, and compacting but not for the purchase of gravel.

From figures made available through the courtesy of the Quebec Department of Roads covering two separate projects, I have calculated the average stabilization costs per cubic yard of aggregate placed as 54 cents.