

LIME TREATMENT OF A DETROIT SILTY CLAY
M 39 - Southfield Expressway at Oakwood Blvd. , Dearborn
(Project U 82192B, C21)

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This study is a part of Research Project R-58 E-17, being conducted by the Research Laboratory Division to determine the value of commercial lime in improving the engineering characteristics of plastic soils. The purpose of this particular portion of the project was to determine whether hydrated lime would improve the characteristics of a soft lacustrine silty clay, found in the Detroit area, to the extent that it would carry normal equipment during construction, even when wet.

The test area is 600 ft long by 100 ft wide and forms part of the foundation for the Southfield Expressway in Detroit, as it passes beneath Oakwood Blvd. (Sta 120+00 to Sta 126+00). The untreated soil was a silty clay with an AASHO classification A-4(9). Hydrated bagged lime, furnished by the U. S. Gypsum Co. , was applied at the rate of 5 percent based on the dry weight of the soil. The project was constructed during the period from October 7 to 14, 1963, under general supervision of the Department's Office of Construction, with immediate project supervision by the Wayne County Road Commission. The contractor was L. A. Davidson.

Construction Operations

The purpose of this particular job was to dry a wet subgrade to such an extent that construction equipment could be readily supported. However, the site surface had been exposed for four or five months to warm, dry weather prior to this phase of the work, resulting in formation of a hard, dry crust over the soft subgrade. This crust was approximately 3 to 4 in. thick with a moisture content of about 15 percent. Below this crust the subgrade moisture was about 30 percent and its supporting value very small.

Bagged lime was spotted uniformly and spread over the dry surface by a crew of eight men, an operation requiring almost two days (Fig. 1). The piles of lime were then further spread by a bulldozer-drawn section of reinforcing mat. This procedure was fast and left a uniform layer of lime over the surface. The area was then lightly disced (Fig. 2) as an initial mixing and to reduce blowing of lime from the surface.

Mixing with a Seaman pulvimixer began at the start of the third day (Fig. 3). In order to obtain a compacted depth of 6 in. the lime and loose soil were mixed to a depth of 8 to 9 in. The Seaman was unable to mix to this depth until the surface had been loosened by a heavily loaded disc. After discing, the Seaman operated to give the required depth of mixing. Heavy discing was kept to a minimum, however, to avoid damage to the grade. Mixing continued throughout most of the day with no addition of water. During mixing an attempt was made to begin compaction with the sheepsfoot roller (Fig. 4). This was not successful because the roller penetrated into the soft subsoil, bringing it to the surface and thereby increasing the mixing required to break down the soil particles. Use of this type roller was discontinued.

Late in the day about 5-percent moisture was added to a small section of the job to see if this would improve mixing conditions and help reduce the size of soil lumps. The following day a check was made of the wetted test area to determine its moisture content and how well the soil had broken down. Inspection showed that the addition of the water had greatly improved the mixing and pulverizing efficiency of the Seaman. The wetted area, however, had dried back to its previous 15-percent moisture during the night.

Based on improved mixing due to water addition, the entire job was watered during subsequent mixing with the Seaman. Water application, however, was uneven causing wet and dry areas which increased the mixing time required. Fig. 5 shows a general view of the job just prior to compaction, with a closeup of the soil-lime mix at this time in Fig. 6.

Compaction with a rubber-tired roller began during the fourth day of construction and continued throughout the fifth day. A closeup view of this operation is shown in Fig. 7. At the end of this compaction period it was found that only 90 percent of maximum had been obtained. Because this was on a Friday, the stabilized area was wetted and left standing until the following Monday, when watering and compaction were resumed and continued until 95-percent maximum T-99 density had been reached. Fig. 8 is a general view of the job at this point. Uneven moisture content is apparent. The darker areas were at near optimum moisture while the lighter areas were drier. Fig. 9 is a closeup view of the more moist compacted areas, showing typical cracking. This condition was not apparent in the dry areas.

After final compaction, samples were taken to check the mixture and to obtain laboratory samples. Fig. 10 shows an augered sample from the lime treated area. The non-cohesive character of the top (lime treated)

portion can be readily noticed as can its contrast to the untreated natural soil below. The average thickness of the lime treated surface was 8 in. after compaction with a range of extremes from 5 in. minimum to 19 in. maximum. At this point the lime treated area offered a fairly stable surface. However, due to the soft subgrade there was movement and some severe rutting under heavy loads. This condition can be seen in the upper right hand portion of Fig. 8. It is possible that an extended curing period, with proper weather, would improve this condition.

When, at the completion of compaction, the treated area was covered with 1 ft of Porous A sand subbase on top of which was placed 4 in. of 24-A select gravel, an entirely satisfactory surface was obtained for all loads used.

TABLE 1
CHANGE IN SOIL PROPERTIES
DUE TO TREATMENT WITH 5-PERCENT LIME

Property	Untreated	Treated
Liquid Limit	29	34
Plastic Limit	17	27
Plasticity Index	12	7
Shrinkage Limit	13	27
Maximum Density, pcf	119	104
Optimum Moisture, percent	14	21
Sand and Gravel, percent	19	53
Silt, percent	36	27
Clay, percent	45	20
AASHO Classification	A-6(9)	A-4(2)

Observations and Conclusions

1. The addition of lime modified the natural soil considerably. Table 1 shows the results of classification tests before and after treatment. A significant point of these data is that the original moisture content of the soft subgrade is now less than the plastic limit of the soil. This could account for the improved workability of the lime treated soil even without a change in moisture content. Also, the optimum moisture has been raised 7 percent, which means that a higher moisture can be used for compaction.

2. The sheepsfoot roller should not be used for compaction of lime stabilized surfaces unless the subgrade is strong enough to support its weight.

3. Optimum mixing efficiency was obtained with a moisture content between optimum and about 4 percent above optimum.

4. Heavy equipment should not be allowed on a lime treated surface until it has either cured for a reasonable period (possibly seven days) or been covered by a selected subbase. It is important that the lime treated area be kept uniformly moist during construction and curing periods even over weekends.

5. When covered by 1 ft of sand and 4 in. of selected subbase, the lime treated area carried a large volume of heavy gravel and concrete trucks without failure at any point. Similar areas, not treated with lime, were reported to have had localized subgrade failure due to the same type of truck traffic. This would indicate that lime treated soil, although unable to carry heavy construction equipment immediately after placement over a weak subgrade, could be used to replace the normal undercutting procedures required for soft subgrade conditions.

6. Some of the immediate value of the lime treatment to the contractor was lost because the surface of the treated area was already dry to begin with. However, there was sufficient evidence to indicate that soft plastic materials can be substantially improved by lime treatment, and that this advantage can be obtained almost independent of prior weather conditions.

7. The cost of this project was \$1.00 per sq yd which is much higher than the reported national average of 40 cents. This is due, primarily, to the small size and experimental nature of this job with a corresponding reduction in contract efficiency.

8. The possibility that a lime treated clay might become frost-susceptible should be considered, especially if it is placed over a subgrade which could provide sufficient water for frost heaving. The M 39 project is being observed systematically for any indication of frost action.

9. Although weather conditions were quite mild during this project (averaging 60 to 70 F during most of the daytime), it was rather late in the season for this type of work. The fullest benefit from lime can be obtained if it is used during warmer summer months and has time to cure over a prolonged warm period.

10. In order properly to control mixing, moisture content, and compaction, it is recommended that an engineer or density inspector be present at all times during the construction of lime stabilization projects.



Figure 1. Spotting and spreading of bagged lime.

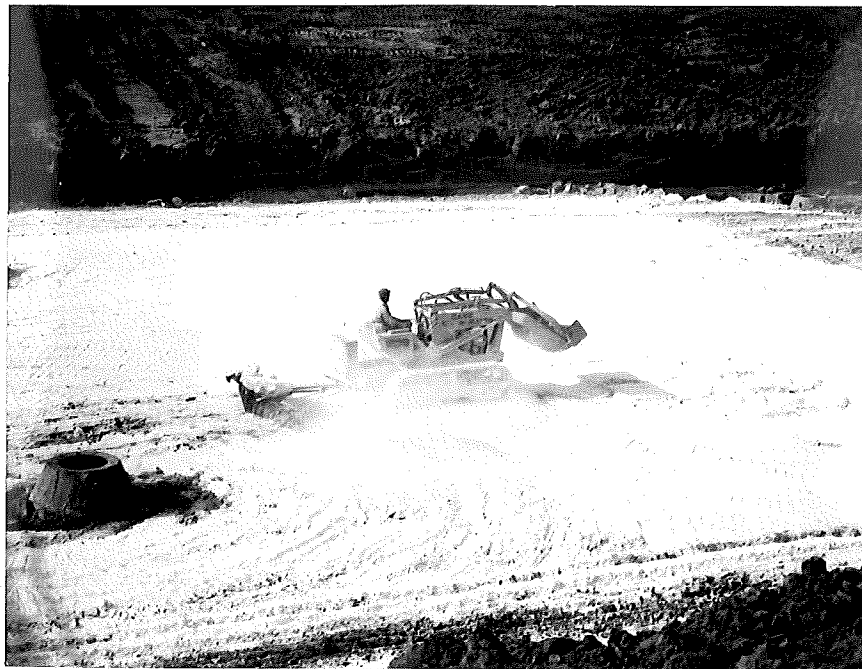


Figure 2. Initial mixing using disc.



Figure 5. General view prior to compaction.



Figure 6. Close-up of mixture prior to compaction.



Figure 7. Compaction with rubber-tired roller.



Figure 8. Uneven moisture distribution after compaction.



Figure 9. Cracking of compacted surface in moist areas (nuclear density gage shown in place).

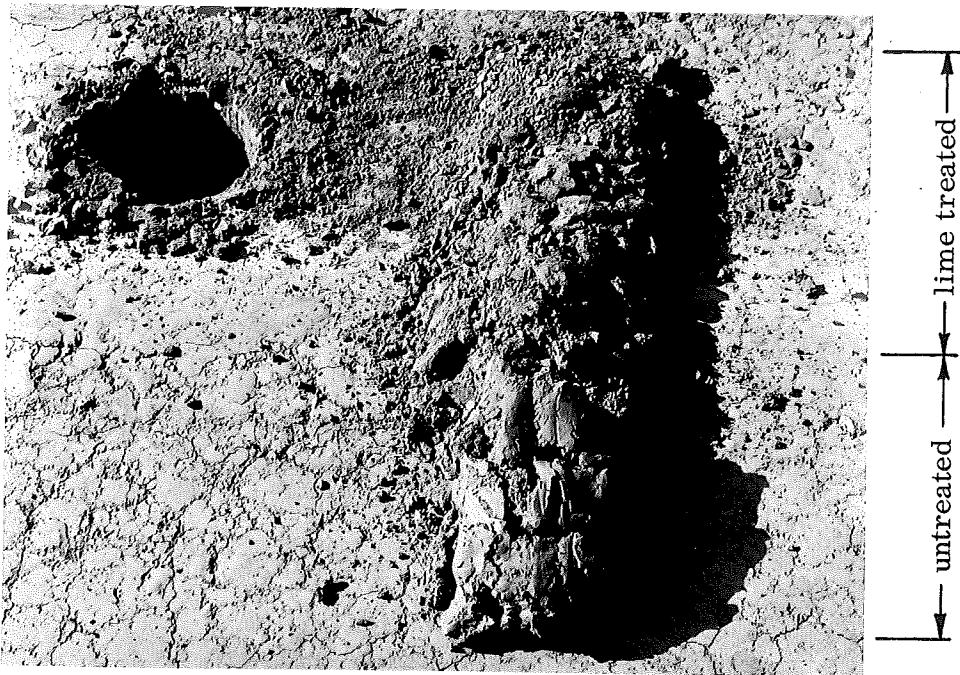


Figure 10. Augered sample showing change in texture of lime-treated sample.