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#39 Lime Soil Stabilization

PROGRESS OF LIME STABILIZATION IN TEXAS*

By

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Supervising Soils Engineer
Texas Highway Department

The use of hydrated lime in stabilizing soils in Texas has increased at a fantastic rate since 1952. No single person or individual group should be accredited with making such rapid progress. Actually, it has required the cooperative efforts of producers, contractors, engineers and other scientific personnel. Your own N.L.A. staff's vision and continued assistance also have been a major contribution. The influence of such personnel on the actual quantities of lime used from 1945 through 1959 will be discussed herein; however, we should be mindful that the old adage, "There is no royal road to success," is still true. In plain words this means that we cannot afford to relax and "live on our laurels" because we still have design and construction problems which have a direct effect upon the efficiency of lime as a stabilizer. It naturally follows that efficiency and costs of a stabilizer have a controlling influence upon sales. These problems, some of which will be discussed later, must be met headon and solutions offered that will either help or satisfy the customer because this is a business where "The customer is always right." Unfortunately, even if wrong, a dissatisfied customer can discourage many others from using a product which he did not like.

The history of ancient uses of lime will not be repeated here, but the Texas story will be discussed in order that we might share some of the marvelous results

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we are enjoying from lime stabilization. Like the ant moving the rubber tree, I have high hopes that many other states will be strengthening their weak subgrades with lime. Contractors, who have played no small part in development of lime stabilization, are consistently calling for more lime stabilization because it affects the economy of construction. Their voices will not be limited to state boundaries. Likewise, road and street designers are finding added economies through the use of lime by reducing depth of base and using the lime-treated layer as part of the base. This will be discussed more fully subsequently.

Recently, we made an analysis of the quantities of lime used by the Texas Highway Department from 1945 through 1959. These data are shown in Figure 1 and Table I. These figures do not include quantities used by contractors to eliminate wet stretches or quantities used by city, county, or federal governmental agencies. It is interesting to note that the quantity of lime used in 1959 is in excess of the total amount of lime produced in Texas in 1945. Lime production quantities were taken from publications issued by the U. S. Bureau of Mines.

This analysis of the growth of lime stabilization will probably lead some lime producers to wonder when they can expect somewhat comparable increases in lime stabilization in their areas to those achieved in Texas. No one knows the answer to this question, but I do know that most all of our state highway departments are operated by honest, devoted and conservative personnel. You can be sure that in due time they will at least see the strengthening benefits of lime-subgrade stabilization, and when they realize that this is an economic construction factor, they will move forward in this field. The conservatism of other state highway departments is somewhat analogous to that found in Texas - for instance, our first job in 1938 which failed due to allowing the base to "ravel out" for six months before

surfacing or Surface sealing, prevented us from using lime again until 1945. From 1945 to 1955 we used lime stabilization spasmodically. As a matter of fact we used as much lime in 1947 as we did in 1955. What I am trying to point out is that we spent 17 years before we reached a definite upward trend. The first seven of these 17 years is inexcusable nowadays, so this leaves 10 years of trials and experiments which seem inevitable, but you must remember that your N.L.A. staff has been promoting experiments in many states for five years. We spent about four years on subgrade treatments before this type of lime stabilization started growing steadily and we still have not convinced all of our districts that this is a good thing to use. It would be my guess that you may have an average of another four or five year period elapse before this fine job your small staff, working on a limited scale, has done will reach the objectives desired. This time element will vary from area to area depending upon local situations, including the extent to which you and your N.L.A. staff will participate in setting up experimental projects and lending all effort available upon request to help solve construction and design problems.

It is believed that the attached photographs will help to show some of the background and construction procedures which have contributed materially to the advancement of lime stabilization.

Photographs 1 and 3 (left lanes) show the condition of one of Mr. Manigault's original experimental sections after 7-1/2 and 14 years' service, respectively. The treated section on U.S. 79 consisted of stabilizing the top 6 inches of old 12-inch gravel base with 3% lime in 1945. Traffic volume increased above 1000 vehicles per day, and it was thought necessary to strengthen the entire road by application of 1-1/2 inches of hot mix overlay without improvement of the existing base. This work was carried out in 1952 and 1953. Photograph 2 and the right

side of Photograph 3 show recurrence of failures six years later on untreated base while the left side of Photograph 3 shows the excellent condition of the lime-treated section after 14 years' service. This illustrates the need for strengthening many old base courses prior to resurfacing.

Photographs 4 through 11 show the use of lime in connection with building foundations of the new Texas Highway Department, Equipment and Shops Building at Austin, Texas. This building was located over a very high volume-change clay which was ponded to remove most of the expansive characteristics of the soil. After ponding, lime was added to the wet soil so that work could progress. Please note that three days of mixing in lime and rolling with a front end loader provided ample support for heavily loaded haul trucks. Photographs 12 through 15 illustrate the same type of construction for a warehouse building in the Bryan District which included lime in the contract for this purpose. The lime-treated clay served not only as a working table but also as a barrier against excessive drying by evaporation. If untreated clay is allowed to dry until it will support loads of working equipment, it usually is dry enough again to swell excessively. Apparently, lime will furnish both high load support and sufficient moisture retention of sublayers. Contractors in our state are well aware of the load support gained by such procedures and often purchase lime at their own expense in order to expedite their work.

Photographs 10 through 19 show a central mix plant and road spreader used on Highway 71 in Fayette County. This is a case where a Cedar Rapids plant was used successfully in pug mixing gravel, sandy soil binder, lime and water all in one operation. Trucks delivered the mix to a Blaw-Knox spreader on the road where compaction was completed a few hours after mixing. This proved to be an economical

operation which we hope to see used on many future jobs of a similar nature.

Photographs 20, 21 and 22 show the addition of lime to plastic red Vernon clay subgrade on Interstate 20 West of Abilene. Approximately 12 inches of gravel subbase, 8 inches of crushed stone base and 3 inches of hot mix asphaltic concrete are to be placed above treated subgrade. The subgrade in this case was stabilized with lime in order to prevent water from permeable gravel subbase entering and softening clay subgrade. Numerous cut sections on this job would have required extensive right-of-way widths in order to extend gravel subbase layer out to slopes for drainage.

Photographs 23 through 29 show application, mixing and compacting of a lime slurry job on Interstate 10 in Chambers County. This was our first attempt to use a commercial lime slurry furnished by the Dow Chemical Company for stabilization of a weak clay subgrade. The treated subgrade was nine inches thick and covered with six inches of "non-pumping" sand-shell, twelve inches of shell concrete surfaced with 1-1/2 inches of bituminous mix. Many problems of delayed compaction and sealing for curing were encountered on this job, but the treatment appears to have been successful in providing a working table. The left side of Photograph No. 28 shows how completely MC-1 asphalt penetrates this lime-treated clay. Only a few asphalt seals are now used because the better practice now appears to consist of covering the treated soil with a layer of granular base or subbase material at an early date.

We could go on and on showing the ingenious contributions that contractors and the industry as a whole have made to make lime stabilization a success such as the Euclid scraper converted into a tank capable of slurrying a truck load of hydrated lime at one time. See Photograph No. 30.

In fairness to both consumer and reliable producers the quality or chemical purity of lime should be controlled. A specification based upon chemical tests which has served our purpose of controlling quality of large quantities of high calcium hydrated lime is given in the Appendix. It is hoped that further improvements in testing techniques will be forthcoming so that dolomitic and other types of limes can be controlled at the plants by tests. Preparation of proper construction specifications is one of the most important but difficult problems facing us today. We are including a set of construction specifications in the Appendix which is an outgrowth of our experience to date.

Many good lime stabilization jobs have been constructed without the benefit of such a specification; however, there have also been a number of projects where specifications were so weak that substandard construction resulted, and the engineer in charge was powerless to demand and obtain anything better than what the contractor was willing to offer. Generally, this was not the fault of the contractor because the specifications did not specify the order of the work necessary to produce a good job. The attached specifications should do much toward being specific relative to the following items:

1. Quality of lime to be used.
2. Minimum strength of final mixture.
3. Screen analysis for mixing requirements of clay-lime mixtures.
4. Time interval between mixing and rolling.
5. Degree of compaction and time allowable for rolling.
6. Curing time.
7. Time allowed prior to covering with next course or sealing.

8. Procedures for trimming off fines or reworking so that surfacing will knit to surface of base.

9. The requirement for the use of surfacings or seal coats for curing.

In conclusion, our experiences with lime stabilization covering analysis of quantities used, quality control of purity, design of pavement structure and construction procedures indicate the following:

1. That lime stabilization in Texas has increased at the fantastic rate of twenty fold in the past four years.

2. This increase has occurred partially as a result of combined efforts of technical and professional personnel of lime producers, contractors and highway departments in seeking ways to construct better roads.

3. Our present letting quantities indicate that the use of lime in soil stabilization continues to gain in spite of a reduction in total lettings.

4. The interest of both engineers and contractors, together with excellence in performance of old lime-treated roads, indicate that lime stabilization is here to stay.

5. Design and construction procedures, which have been discussed very briefly, probably will play an increasingly important role in the growth of lime stabilization.

It is hoped that our experience will encourage other states and governmental agencies to enjoy the benefits of lime stabilization as we have and at the same time avoid unnecessary delays due to trial and error experimentation which we have already been through.

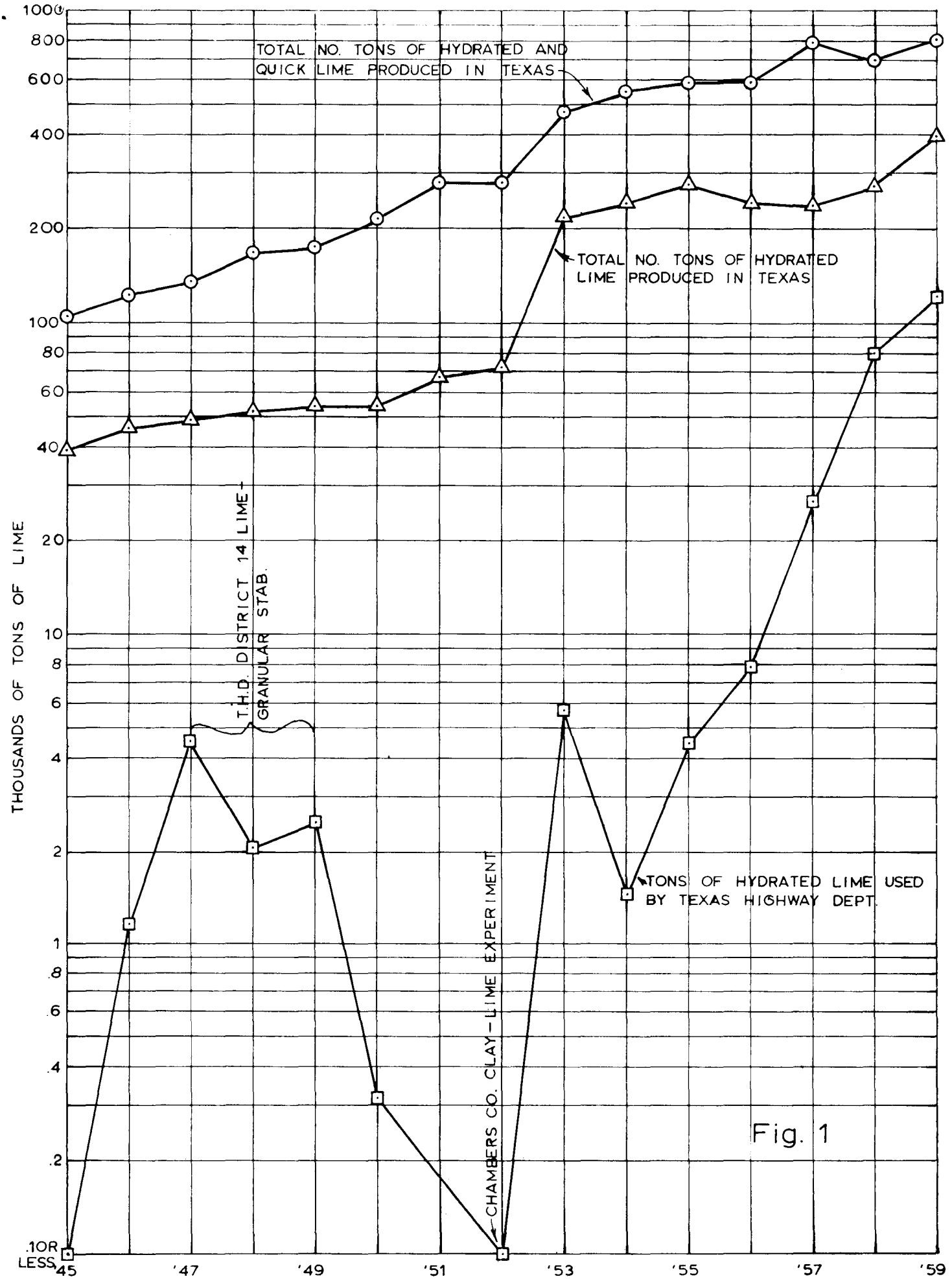

TOTAL NO. TONS OF HYDRATED AND QUICK LIME PRODUCED IN TEXAS
TOTAL NO. TONS OF HYDRATED LIME PRODUCED IN TEXAS
TONS OF HYDRATED LIME USED BY TEXAS HIGHWAY DEPT.
T.H.D. DISTRICT 14 LIME-GRANULAR STAB.
CHAMBERS CO. CLAY-LIME EXPERIMENT
THOUSANDS OF TONS OF LIME
1000
800
600
400
200
100
80
60
40
20
10
8
6
4
2
1
.8
.6
.4
.2
.10R LESS
'45
'47
'49
'51
'53
'55
'57
'59

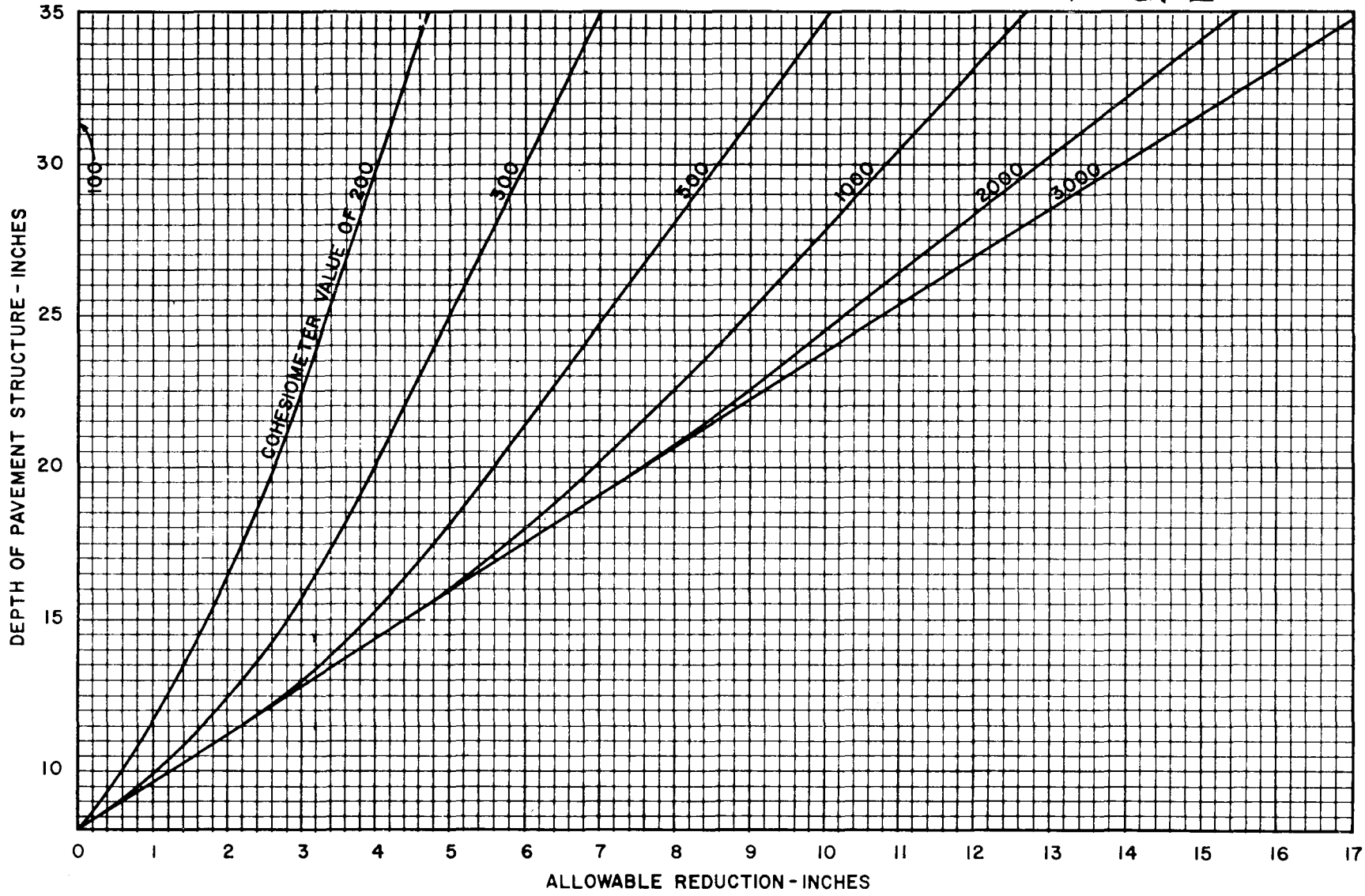
Fig. 1

TABLE I

USE OF LIME BY YEARS

YEAR	TONS OF LIME USED FOR CONSTRUCTION	TONS OF LIME USED FOR MAINTENANCE	TOTAL TONS OF LIME USED FOR THE YEAR
1959	113,399.71	8,087.00	121,486.71
1958	71,282.35	8,414.00	79,696.35
1957	26,176.00	760.00	26,936.00
1956	7,000.23	851.00	7,851.23
1955	4,058.85	416.00	4,474.85
1954	1,391.70	50.00	1,441.70
1953	5,671.30		5,671.30
1952	90.00		90.00
1950		315.00	315.00
1949	210.00	2,281.00	2,491.00
1948	1,250.50	826.00	2,076.50
1947	3,039.00	1,478.00	4,517.00
1946	566.00	592.00	1,158.00
1945		30.00	30.00

FIG. 2



THICKNESS REDUCTION CHART FOR STABILIZED LAYERS

b. Hydrated lime shall be stored and handled in closed containers until immediately before it is applied. If storage bins are used, they shall be totally enclosed. Sack hydrated lime shall be stored in weather-tight buildings.

c. If lime is furnished in trucks, each truck shall have the weight of lime certified on public scales or the contractor shall place a set of standard platform truck scales or hopper scales at a location approved by the Engineer. The scales shall be accurate to within five (5) pounds per one thousand (1000) pounds total load. The truck scales shall have a rated capacity of not less than five thousand (5000) pounds more than the total load to be weighed. Should the contractor furnish scales at the job site, a weather-tight building of sufficient size to house the checker while operating the scales shall be provided.

d. If lime is furnished in bags, each bag shall bear the manufacturer's certified weight.

4. MIXING:

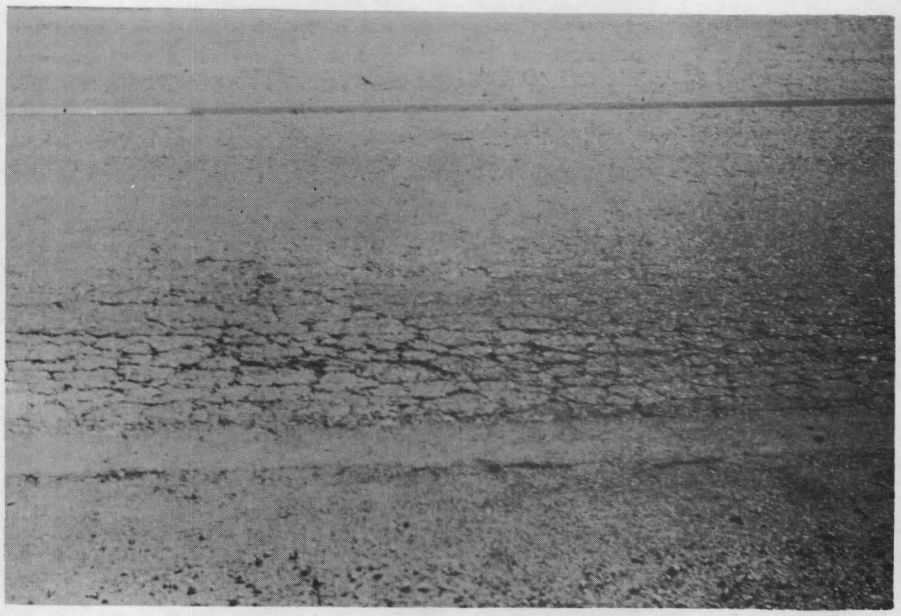
a. General Provisions

(1) It is the primary requirement of this specification to secure a completed course of subgrade treatment, subbase, and/or base containing a uniform lime mixture free from loose or segregated areas of uniform density and moisture content, well bound from top to bottom, and with a smooth hard surface. It shall be the responsibility of the contractor to regulate the sequence of his work, to apply the proper amount of lime, maintain the work, or rework the course, as necessary, to meet the above requirements. After a course has been completed, it shall be maintained by light sprinkling as directed by the Engineer until the next course is applied.

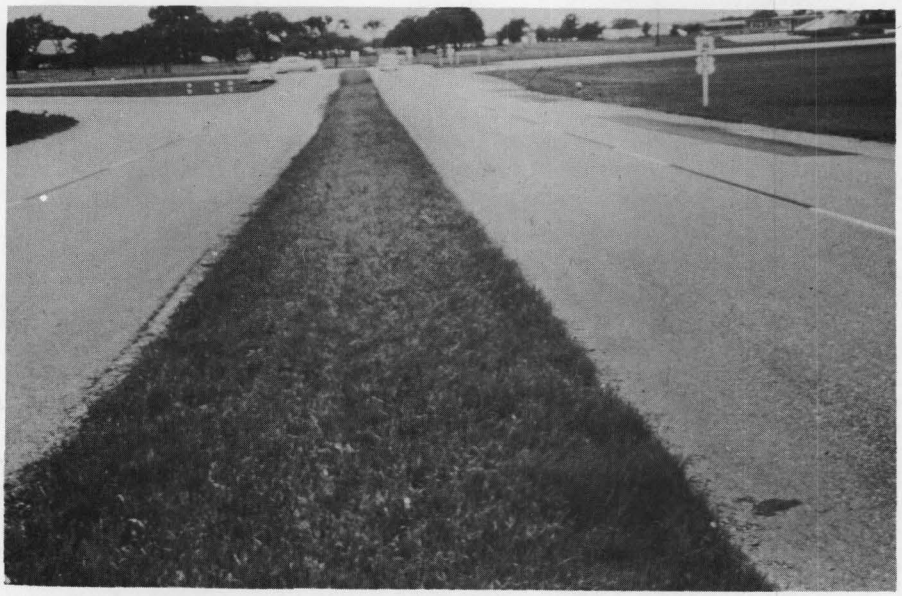
(2) Prior to beginning any lime stabilization, the roadbed shall be excavated and shaped in conformity with the typical sections shown on the plans

APPENDIX TO:
"PROGRESS OF LIME STABILIZATION IN TEXAS"

Photograph 1, showing excellent condition of original surfacing of the 7-1/2 year old Manigault lime stabilization experimental section (on left) near intersection of U.S. 79 and U.S. 81 at Round Rock, Texas. Patches on right are on same gravel base material which has not been treated with lime. Note stakes set for resurfacing.



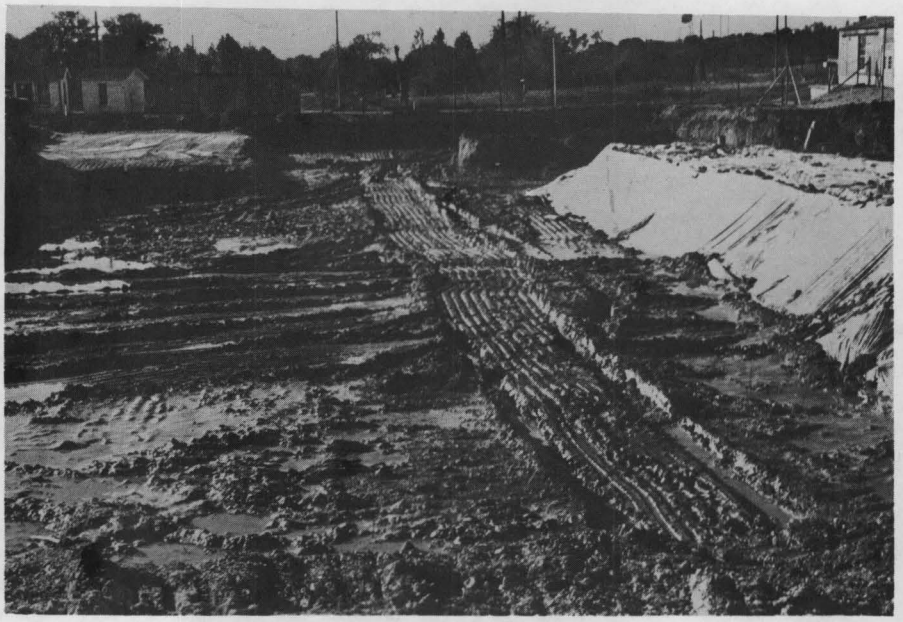
Photograph 2, taken 6 years after Photograph 1, showing nature of failure in untreated section. See Photograph 3 for patching.



Photograph 3, taken 6 years later at same location as Photograph 1. Note patches on untreated section at right and excellent condition of treated section at left after 14 years of service.

AUSTIN EQUIPMENT AND SHOPS BUILDING
(Photographs 4 to 11, incl.)

Photograph No. 4, Ponding of clay subsoil.

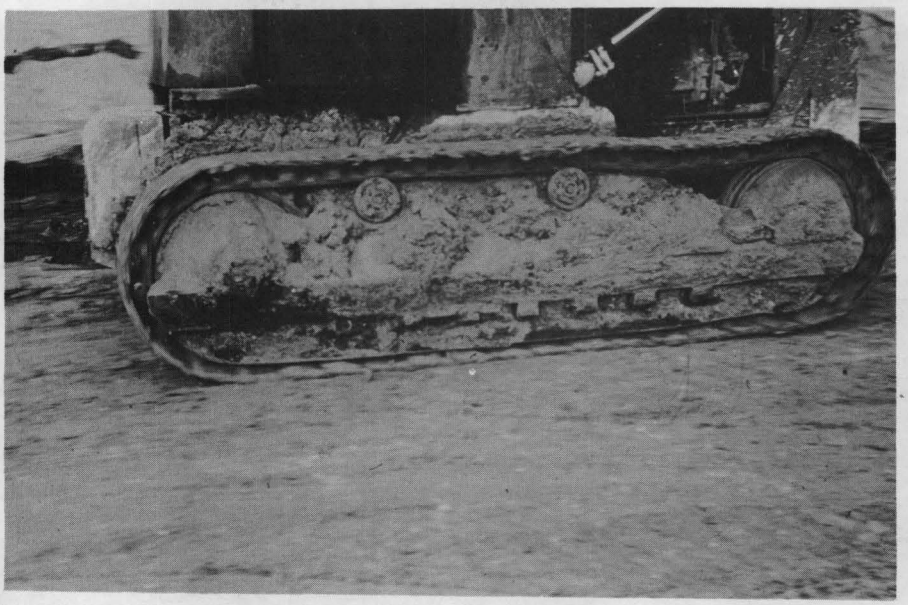


Photograph No. 5
Soft condition of subgrade after 30 days ponding.

Photograph No. 6
Dumping of lime on subgrade.

Photograph No. 7
Mixing lime into soft subgrade with
bucket teeth of front end loader.

Photograph No. 8
Same as Photograph No. 7, showing streaks
left by teeth of front end loader bucket.



Photograph No. 9
Clay lime mixture compacted so as to be stable enough to support front end loader.

Photograph No. 10
Lime-treated subgrade supports heavy loads of base material only 3 days after adding lime to very soft clay subgrade.

Photograph No. 11
Compacting crushed rock fill to specified density with vibratory roller.

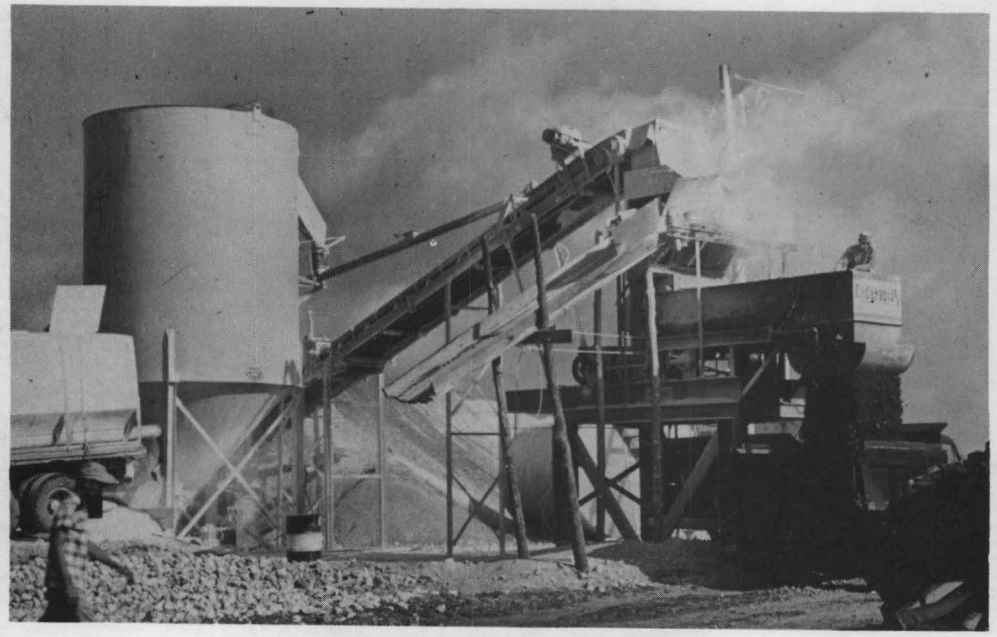
BRYAN WAREHOUSE
(Photographs 12 thru 15, Incl.)

Photograph No. 12
Showing application of lime.

Photograph No. 13
Showing application of lime.

Photograph No. 14
Showing mixing operations.

Photograph No. 15
Showing mixing operations.



Photograph No. 16, showing overall view of mixing plant. Note mix dropping from pugmill into truck.

Photograph No. 17, Note lime being added to conveyor belt carrying gravel and soil binder.

Photograph No. 18, showing final mix being end dumped into spreader box.

Photograph No. 19, showing the Blaw-Knox Spreader Box.

INTERSTATE 20, WEST OF ABILENE
(Photographs 20 thru 22, Incl.)
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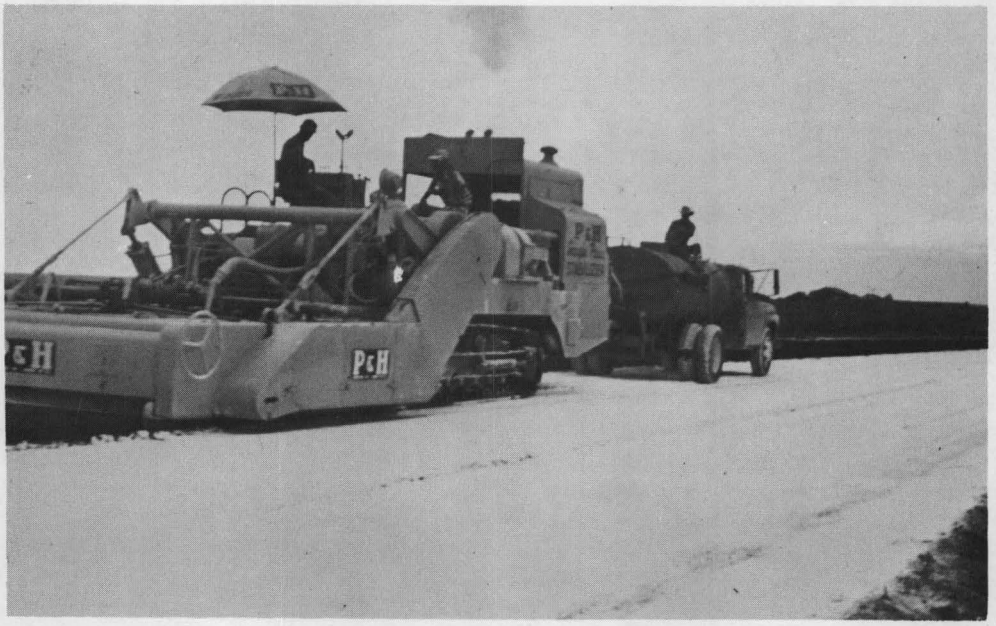
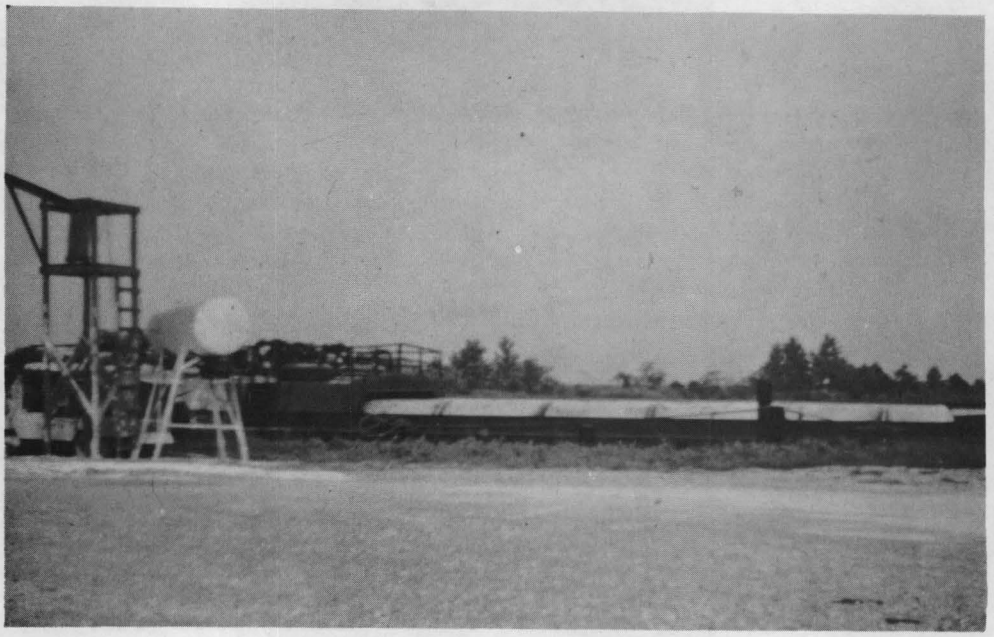
Photograph No. 20, showing lime and water being added to plastic red Vernon clay with a P&H mixing machine.

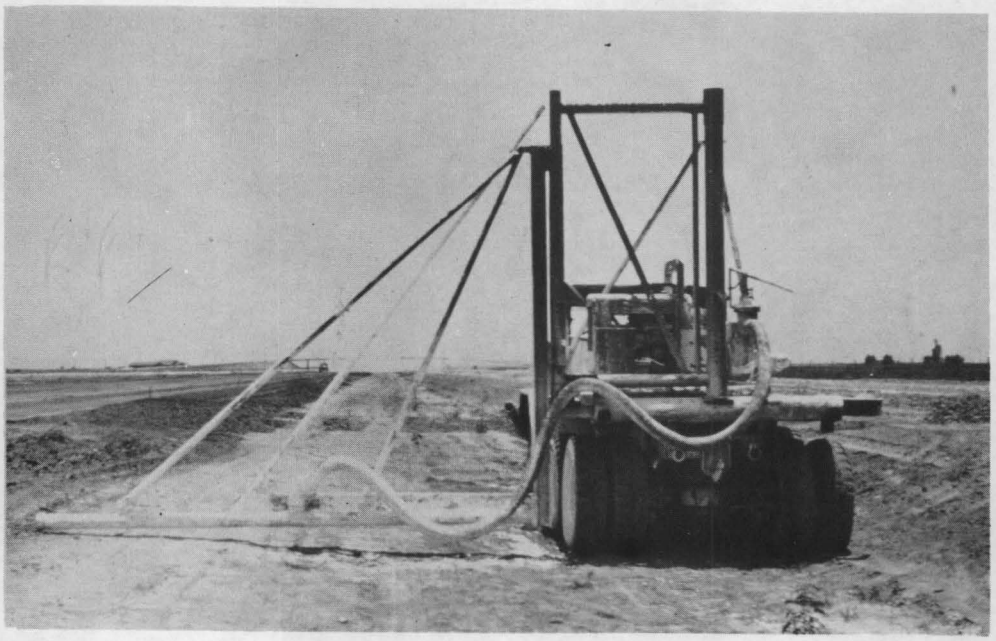


Photograph No. 21, similar to No. 20 except note water truck in fro of P&H mixer.

Photograph No. 22. Covering of lime stabilized subgrade with gravel subbase material promptly after curing 7 days.

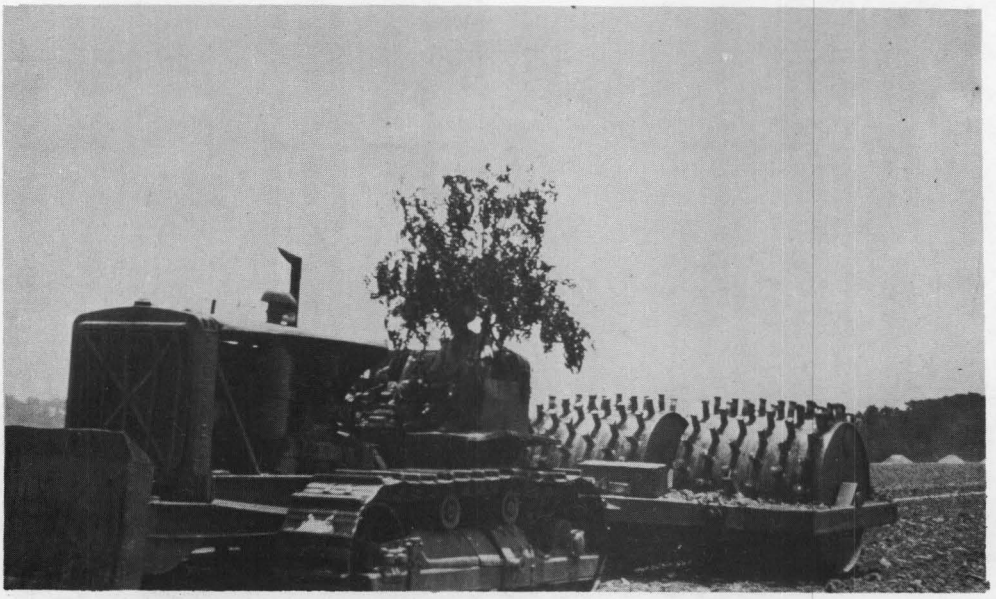


Photograph No. 23, shows Dow Chemical Company's barge which transports 5, 50-thousand gallon tanks of lime slurry. Slurry is pumped into tank trucks for hauling to job.

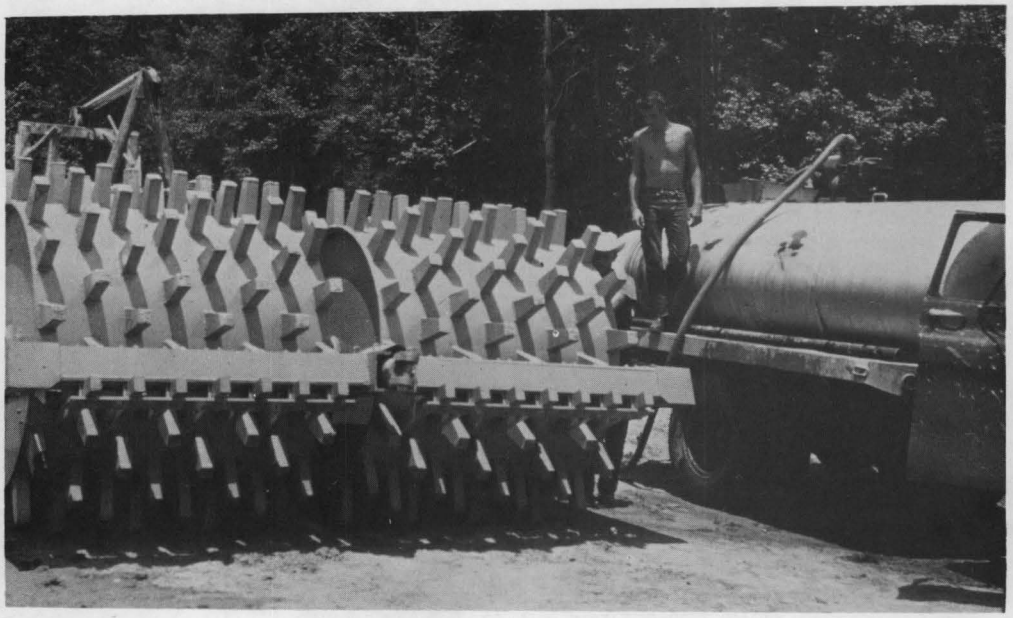


Photograph No. 24, Special Spray Bar Truck used for transfer of lime slurry from tank trucks to soil.

Photograph No. 25.
Heavy duty Seaman Pulverizer used for mixing lime slurry with clay.

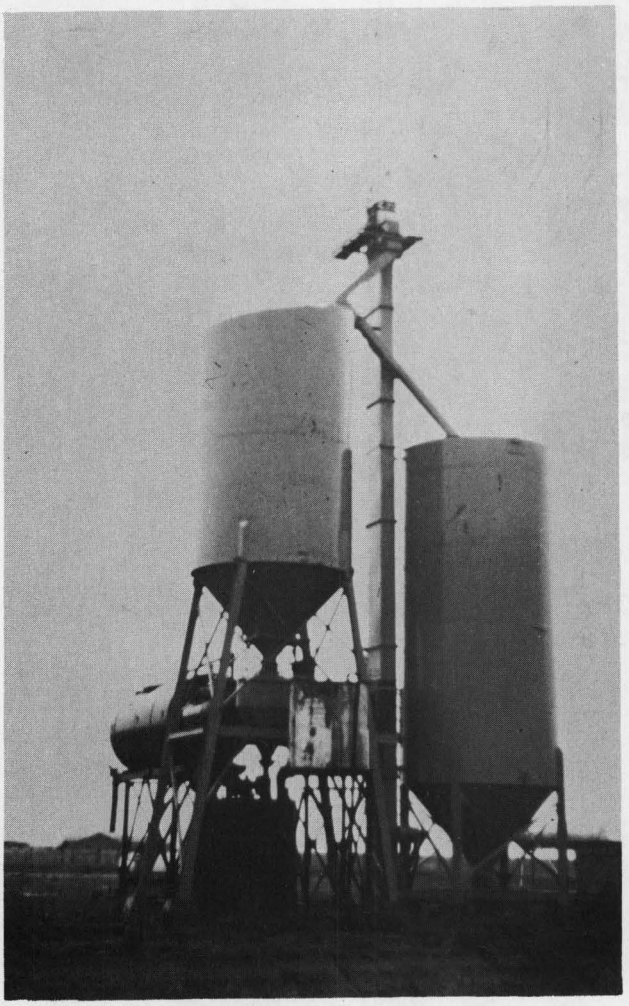


Photograph No. 26.
Rolling lime-soil mixture with sheepsfoot roller.



Photograph No. 27. Large Sheepsfoot roller used in compacting thick layers of lime-treated clay.

Photograph No. 28. Clay-lime subgrade cured by sealing with MC-1 at left (note penetration) and asphaltic emulsion at right. It was decided to place sand-shell subbase material on clay-lime at an early date instead of trying to seal with asphalt.



Photograph No. 29

One of the most elaborate plants for making lime slurry from hydrated lime in powder form

Photograph No. 30
Contractor adapts Euclid earth moving equipment into slurry tank in the Bryan District.

SPECIAL CONSTRUCTION SPECIFICATION
FOR
"LIME STABILIZATION"

1. DESCRIPTION: This item shall consist of stabilizing base, subbase, or subgrade treatment materials by mixing them with lime and compacting the mixed material in conformity with the typical sections shown on the plans and to the lines and grades established by the Engineer.

2. MATERIALS:

a. Base and subbase materials shall meet the requirements shown on the plans or in standard specifications.

b. The lime shall meet the requirements of the Texas Highway Department Special Specification "Hydrated Lime for Soil Stabilization Purposes".

c. The final mixture shall be designed with the intention of producing the minimum strength shown on the plans or specified elsewhere when tested in accordance with special laboratory procedures*.

3. EQUIPMENT:

a. Equipment necessary for the proper construction of the work shall be on the project, in firstclass working condition, before construction operations will be permitted to begin. The contractor shall at all times provide sufficient equipment to enable continuous prosecution of the work. The equipment shall be operated by experienced and capable workmen, and shall be that necessary to provide subgrade treatment, subbase, base, and/or salvaged base material meeting the requirements herein.

*Usually a minimum of 100 p.s.i. unconfined compressive strength or a C.B.R. or Resistance value of 80 after 18 days curing. Each agency should refer to a detailed method of test which they have been using.

and to the lines and grades established by the Engineer.

(3) Lime shall be applied only to such area that the first preliminary mixing operations can be completed during the same working day.

(4) The placing and mixing of the lime with the material shall be obtained by the method hereinafter described as "Dry Placing" or the method hereinafter described as "Slurry Placing". If no particular method is shown on the plans, the contractor may use his option of either method.

b. DRY PLACING: When the Dry Placing method is required, the following provisions shall govern:

(1) Subgrade Treatment Materials:

(a) The prepared subgrade treatment material shall be excavated to the secondary grade (proposed bottom of the lime treatment) and, except as provided below, the material removed or windrowed on the secondary grade. Before proceeding further with the stabilizing, any wet or unusually soft areas in the secondary grade shall be corrected by scarifying and adding lime, as directed by the Engineer, so that the secondary grade is of uniform stability.

Alternate Method: If the contractor elects to use a cutting and pulverizing machine that will remove the subgrade material accurately to the secondary grade and pulverize the material at the same time, he will not be required to expose the secondary grade nor windrow the material, but will be required to roll the subgrade, as directed by the Engineer, before using the machine and correct any soft areas that this rolling may reveal. This alternate method will be permitted only where a machine is provided of such design that will insure the material being cut uniformly to the proper depth at all times and with cutters of such design that will plane the secondary grade to a smooth surface over the entire width of the cut.

The machine shall be of such design that a visible indication is given at all times that the machine is cutting to the proper depth.

(b) The required amount of lime shall then be uniformly spread on the prepared subgrade treatment material by an approved screw type spreader box or sack distribution. A maintainer shall not be used to spread the lime.

(c) The material shall then be moistened with water by an approved method as directed by the Engineer until the proper moisture content has been secured. Moistening shall be continued during the mixing operations as directed.

(d) First Mixing: The subgrade treatment material and lime shall then be thoroughly mixed by approved road mixers or other approved equipment, and the operation of moistening and mixing continued until, in the opinion of the Engineer, an intimate, homogeneous mixture of soil and lime is obtained, free from all clods or lumps.

(e) In plastic clay soils (or other materials difficult to mix with lime) the material shall first be mixed with lime, brought to the proper moisture content, and left to cure one to four days as directed by the Engineer. During the curing period the material shall be kept moist as directed.

(f) Final Mixing: After the required curing time is completed, the final mixing shall begin. The material shall be uniformly mixed by approved methods so that when all nonslaking plus 1/4-inch aggregates are removed, the resultant mix shall meet the following requirements when dry screened on a dry weight basis:

Passing 2" screen	100%
Passing 1/4" screen, min.	60%

(2) Subbase and Base Materials: Various materials required under this item may be mixed by either a central mixing plant off the limits of the project or in place on the road with approved traveling mixers or blades. If blade or travel

mixing operations are used, the material shall be placed and spread in the required amount per 100' station and the required amount of lime shall be applied, moistened and mixed as described above.

c. SLURRY PLACING: When the "slurry placing" method is required, the following provisions shall govern:

(1) Subgrade Treatment Materials:

(a) The prepared subgrade treatment material shall be excavated accurately to the secondary grade (proposed bottom of the lime treatment) and except as provided below, the material removed or windrowed on the secondary grade. Before proceeding further with the stabilizing, any wet or unusually soft areas in the secondary grade shall be corrected by scarifying and adding lime, as directed by the Engineer, so that the secondary grade is of uniform stability.

Alternate Method: If the contractor elects to use a cutting and pulverizing machine that will remove the subgrade material accurately to the secondary grade and pulverize the material at the same time, he will not be required to expose the secondary grade nor windrow the material but will be required to roll the subgrade, as directed by the Engineer, before using the machine and correct any soft areas that this rolling may reveal. This alternate method will be permitted only where a machine is provided of such design that will insure the material being cut uniformly to the proper depth at all times and with cutters of such design that it will plane the secondary grade to a smooth surface over the entire width of the cut. The machine shall be of such design that a visible indication is given at all times that the machine is cutting to the proper depth.

(b) The required amount of lime shall then be applied by mixing with water in water trucks or approved distributors and applied as a mixture or

slurry, with the distribution of the lime being attained by successive passes over a determined section of roadway. The water truck or distributor shall be so equipped with an agitator which will keep the lime and water in a consistent mixture.

(c) First Mixing: The slurry shall then be placed and thoroughly mixed to the required depth by approved road mixers or other means of pulverizing and mixing, approved by the Engineer, until in the opinion of the Engineer, an intimate, homogeneous mixture of soil and lime is obtained, free from all clods or lumps. Moistening shall be performed as directed by the Engineer.

(d) In plastic clay soils (or other materials difficult to mix with lime), the material shall first be mixed with the lime slurry, then left to cure one to four days as directed by the Engineer. During the curing period the material shall be kept moist as directed.

(e) Final Mixing: After the curing time is completed, the final mixing shall begin. The material shall be uniformly mixed by approved methods. The mixture (exclusive of all plus 1/4-inch nonslaking aggregates) when properly mixed, shall meet the following requirements when dry screened on a dry weight basis:

Passing 2" screen	100%
Passing 1/4" screen, min. ...	60%

(2) Subbase and Base Materials: Various materials required under this item may be mixed by either a central mixing plant off the limits of the project, or in place on the road with approved traveling mixers or blades. If blade or travel mixing operations are used, the material shall be placed and spread in the required amount per 100' station. The required amount of lime slurry shall be applied, moistened, and mixed as described above.

5. COMPACTION:

a. Unless otherwise directed by the Engineer, each layer or course shall be compacted to the densities required by the plans and governing specifications

within three calendar days after final mixing. If the controlled "Density Method" is not required, ordinary compaction methods will govern.

b. Layers up to and including eight (8) inches uncompacted thickness may be mixed and compacted in one operation. Layers of over eight (8) inches uncompacted thickness shall be mixed and compacted in two, separate courses of equal thickness.

c. After the final layer or course of the subgrade treatment, subbase or base has been compacted, it shall be brought to the required lines and grades in accordance with the typical sections. The completed section shall then be finished rolled as directed with a pneumatic or other suitable roller sufficiently light to prevent hair cracking. The completed section shall be moist-cured for a minimum of seven days before further courses are added or any traffic is permitted unless otherwise directed by the Engineer. In cases where subgrade treatment or subbase sets up sufficiently to prevent objectionable damage from traffic, such layers may be opened to traffic within two days after compaction.

(1) Subgrade Treatment and Subbase Materials: The surface of the material shall be protected from rapid drying by light moistening until further material is added. Top of treated layer shall be sealed with asphaltic material or covered with a course of subbase or base material within fourteen (14) calendar days after compacting.

(2) Base Materials: The final course of base shall be kept moist by sprinkling for a minimum of 7 days unless a bituminous seal coat for curing is placed. Traffic shall not be allowed on such curing seal coats for a period of not less than 7 days after compaction. Unless otherwise directed by the Engineer, the final course of base shall be sealed or surfaced within 14 days after completion of compaction. Prior to placing the surfacing on the completed base, the final course

of base shall be dried of all visible free moisture. Where there is evidence of shrinkage, scabing or weakness during brooming operations, the base shall be "tight bladed" to remove excessive fines or a minimum of 3 inch depth shall be reworked using additional lime as directed by the Engineer. If these weaknesses together with "pot holing" from traffic can be eliminated by application of single surface treatment for curing purposes, it shall be placed within 2 to 7 days after compacting.

d. Hydrated lime that has been exposed to open air on the job for a period of 6 hours or more, or to moisture for any length of time, will not be accepted for payment.

6. ALTERNATE CONSTRUCTION METHODS: The contractor will be permitted to utilize alternate construction methods suggested by him, with the approval of the Engineer, provided such methods result in stabilized material meeting the specifications herein described.

7. MEASUREMENT:

a. Stabilized subgrade treatment of the depth indicated on the plans shall be measured by the square yard to neat lines as shown on the typical cross sections. The quantity of "Lime", in tons, shall be measured on hopper scales or truck scales in approved vehicles; or if furnished in bags, by the manufacturer's certified weight on each bag.

8. PAYMENT: Work performed and materials furnished as prescribed by this specification and measured as provided under "Measurement" will be paid for at the unit price bid for "Lime" and for "Stabilized Subgrade Treatment", which prices shall be full compensation for furnishing all labor, materials, tools, equipment, for loosening, mixing and pulverizing, for spreading, shaping and maintaining,

for all blading and manipulations required, for all hauling and freight involved and all incidentals necessary to complete the work except "Springling" and "Rolling". All "Sprinkling" and "Rolling" performed as required will be measured and paid for in accordance with the provisions governing the items of "Springling" and "Rolling", respectively.

TEXAS HIGHWAY DEPARTMENT
SPECIAL SPECIFICATION
for
QUALITY OF "HYDRATED LIME FOR SOIL STABILIZATION PURPOSES"

Scope:

1. These specifications cover hydrated lime of a commercial type and grade considered suitable for use in the stabilization of soils and soil-aggregate mixtures for road base and subbase construction. These specificatinns apply specifically to the normal hydrate of limes made from "high-calcium" type limestone. Should other classes or types of lime hydrate be desired for use in stabilization work, they will be considered under separate specifications written specifically to cover the type of lime product involved.

Definition:

2. Hydrate Lime for Stabilization Purposes: A dry powder obtained by treating quicklime with water enough to satisfy its chemical affinity for water under the conditions of its hydration. This material is to consist essentially of calcium hydroxide or a mixture of calcium hydroxide and a small allowable percentage of calcium oxide, magnesium oxide and magnesium hydroxide.

Chemical Composition:

3. When sampled and tested according to prescribed Texas Highway Department procedure, stabilization lime shall conform to the following requirements as to chemical composition:

Hydrate alkalinity, calculated as % by weight $Ca(OH)_2$, min. 90.0%

Unhyrated lime content, calculated as % by weight CaO, max. 5.0%

"Free water" content, calculated as % by weight H_2O, max. 4.0%

Residue:

4. The percentage residue of hydrated lime for stabilization purposes shall conform to the following requirements:

Residue retained on a No. 6 (3360-micron) sieve, % by weight, max. ... 0.0%

Residue retained on a No. 10(2000-micron) sieve, % by weight, max. ... 1.0%

Residue retained on a No. 30(590-micron) sieve, % by weight, max. ... 2.5%

Sampling and Testing:

5. The sampling and testing of hydrated lime for stabilization purposes shall be conducted in accordance with Part I of Texas Highway Department Procedure No. 134 as revised August, 1959. This revised procedure is entitled: "Sampling and Testing of Hydrated Lime and Lime Slurry for Stabilization Purposes".