Lime-Soil Mixture Design Considerations for Soils of Southeastern United States

LARRY W. LOCKETT AND RAYMOND K. MOORE

The Thompson procedure for lime-soil mixture design should be modified when soils of the southeastern United States are evaluated. The dominance of montmorillonite in the clay fraction of some Southeastern clays, especially those of the Alabama and Mississippi blackbelt, creates the need for careful consideration of compaction moisture contents for the lime-treated specimens. The effect of lime modification on these clays causes the optimum moisture content to increase by as much as 20 points (based on the increase in plastic limit). Therefore, the lime-treated soil must be compacted at a higher moisture content than the untreated soil. Although the different moisture contents confound the comparisons of unconfined compressive strength, the potential for moisture deficiency in the lime-treated material must be eliminated. A comparison of plastic limits for the untreated and lime-treated soil will provide an indication that the lime-soil mixture design will require this modification. The use of a modified accelerated curing procedure is recommended for soils of the southeastern United States. Data developed in this research program indicate that the Thompson-accelerated curing criteria of 48 h at 120°F (49°C) overestimate the 28-day, 75°F (24°C) unconfined compressive strengths of lime-treated blackbelt soils by an average of 22 percent. A 65-h, 105°F (41°C) accelerated-curing sequence underestimates the 28-day, 75°F (24°C) unconfined compressive strengths by approximately 25 percent. We, therefore, recommend that a 72-h (3 days is more convenient for laboratory scheduling than 65 h) accelerated-curing sequence at 105°F (41°C) be employed when the Thompson procedure is used for Southeastern soils.

Two major considerations for lime-soil laboratory mixture design procedures involve selection of the specimen preparation procedure and the curing temperature and curing time regime to simulate field curing. The Thompson procedure of lime-soil mixture design (1,2) has been evaluated for its use with soils of the southeastern United States. The results of this study indicate that modifications of the original procedure are desirable when the clay soils of the Southeast are being evaluated for their lime reactivity.

SPECIMEN PREPARATION

The Thompson procedure (1,2) uses a comparison of unconfined compressive strengths by using untreated and lime-treated compacted soil specimens. The selection of moisture contents for the compacted specimens is critical for the proper densification and for the lime-soil-water modification and stabilization reactions. Ideally, the moisture contents for the untreated and lime-treated compaction specimens would be identical to eliminate confounding of moisture content with the comparison of unconfined compressive strength, which is directly affected by moisture content.

Research reported by Moore and Brown (3) and Rosser and Moore (4) concerning the lime treatment of Alabama blackbelt soils has indicated the likely possibility that lime reactivity of heavily montmorillonitic Southeastern soils is underestimated by using moisture contents for untreated and lime-treated soils based on the approximate optimum of the untreated material. The changes in the engineering properties caused by the lime-modification mechanisms appear to increase the required moisture for the lime-treated specimens. Therefore, different moisture contents would be necessary to obtain an accurate measurement of lime reactivity.

ACCELERATED CURING OF LIME-TREATED SOILS

Both curing time and curing temperature have a dramatic effect on the increase in strength of lime-treated soils (5-9). As early as 1961 Herrin and Mitchell found that the increase in the rate of strength was directly proportional to curing temperature (9). When Thompson originally defined lime reactivity as the difference between the maximum compressive strength of the lime-soil mixtures and the compressive strength of the natural soil, he selected a 28-day curing period at 25°C (73°F) because (a) field conditions may not allow longer curing periods; (b) if the treated soil is lime reactive, the pozzolanic compounds will develop to a significant degree within this time period; and (c) curing temperatures in excess of 60°C (140°F) are unrealistic when compared with field conditions (10).

Various researchers have used the effect of short-term elevated temperature to accelerate curing periods in the laboratory to predict 28-day strengths (10). Anday (11) analyzed both fieldand accelerated-curing data for Virginia soils on a strength versus maturity basis. Maturity was defined as the product of curing temperature and its duration; therefore, the concept of degree-days as a measure of maturity was introduced. Anday arbitrarily selected 0°F (-18°C) as the datum temperature. The round figure of 3000 Fahrenheit degree-days (40 days 75°F or 24°C) for field curing was selected for comparative analyses. This research indicated that short-term laboratory curing at both 120° and 140°F (40° and 60°C) could be used to reasonably predict 40- to 45-day field strengths. However, Anday recommended two days at 120°F (49°C) to simulate 40- to 45-day field strengths because (a) when compared with field conditions the temperature is more realistic, (b) less moisture loss, (c) convenience in 48-h curing time, and (d) better accuracy.

Laguros, Davidson, Handy, and Chu (5,12) reported that strengths induced by temperatures in excess of 140°F (60°C) may very well never be obtained through normal curing. Their work with a Wisconsin lime-treated loess cured at 140°F for 7 days generated strengths that could not be matched by curing at 70°F (21°C) for as long as 160 days. On the other hand, strengths obtained after 7 days of curing at 110°F (43°C) were indicative of those produced by normal curing at 70°F for 80 days.

Davidson, Mateos, and Barnes (5,10,13) reported that the strength of a Kansan till stabilized with lime and a small percentage of sodium hydroxide and cured for 28 days at 70°F (21°C) could be approximated by samples cured for 2 days at 100°F (38°C).

Howard (5,10) investigated several accelerated-curing schemes for lime-treated kaolinitic clays in South Carolina. He reported that accelerated curing for 24, 40, 48, and 72 h at 120°F (49°C) approximated 20, 40, 60, and 90 days of laboratory curing at 72°F (22°C). However, he also reported that different lime percentages resulted in different curing periods to predict 28-day normally cured strengths. To approximate 28-day normal strengths for 4.5, 6.5, and 8.5 percent lime in the mixtures required 29, 26, and 34 h at 120°F, respectively.

Drake and Haliburton's work (5,10,14) with two Oklahoma lime-stabilized soils indicated that the most appropriate accelerated-curing temperature was

105°F (41°C). The time-strength curve generated for Permian red clay cured at 120°F (49°C) has neither the general shape nor slope of the curve produced by samples cured at 80°F (27°C) in a moist atmosphere. The researchers proved through differential thermal analysis that pozzolanic products generated at 80°F were mineralogically identical to those created at 105°F. Therefore, since temperatures in excess of 105°F may produce completely different pozzolanic reaction products, as opposed to simply accelerating their formation, Drake and Haliburton (1,6,10) recommended that accelerated curing temperatures be limited to 105°F.

Data developed by Ruff and Ho (7) and Townsend and Donaghe (9) suggest that the temperature at which a different type pozzolanic reaction product is generated lies between 73° and 104°F (23° and 40°C).

Biswas (5) evaluated the effects of several elevated curing temperatures for periods as long as 120 h on a variety of soils. Contrary to the results reported by Drake and Haliburton, Biswas's findings indicate that all three elevated temperatures (105°, 120°, and 140°F) produced pozzolanic products similar to those generated by normal curing. Biswas concluded that either 30 h at 120°F (49°C) or 65 h at 105°F (41°C) could be used to approximate normal curing at 75°F (24°C) for 28 days, but the lower curing temperature was recommended because it is more realistic, less sensitive to changes in the curing period, and creates less moisture loss.

As a result of their work with Vicksburg silty clay and Vicksburg buckshot clay, Townsend and Donaghe (9) concluded that a universal standard accelerated-curing period for predicting 28-day normal curing strengths is not tenable. They further concluded that the question of whether or not a soil is lime reactive depends on the evaluation criteria. In addition, their results indicate that any criteria that use curing temperatures in excess of 105°F (41°C) are misleading. They report that this is because all of the lime-treated soils in their study cured at 120°F (49°C) met Thompson's criteria (Δq_u > 50 lb•f/in²) but only the silty soils exhibited the necessary strength gains to be termed lime reactive when cured at 75°F (24°C) for 28 days. Also, only the clay soils passed Biswas's reactivity criteria (minimum q_u of 100 lb•f/in² for 30 h at 120°F or 65 h at 105°F), which was intended to forecast lime reactivity based on normal curing procedures (5,9).

Townsend and Donaghe (9) reviewed the existing maturity prediction models for concrete and concluded that none are suitable for use with lime-treated soils. Therefore, a method based on 7-day normal curing strengths and strengths accelerated by curing at 105°F (41°C) was devised to estimate 28-day normal curing strengths. They demonstrated with data developed by Biswas (5) that the method is reasonably accurate up to about 30 normal curing days where the predictions begin to diverge from actual strengths.

MATERIALS

The 11-soil series (Boswell, Demopolis, Eutaw, Houston, Kipling, Leeper, Oktibbeha, Sumter, Susquehanna, Vaiden, and Wilcox) evaluated in this study were typical of those investigated by Rosser and Moore (4). Table 1 (4) presents a summary of selected physical data for the soil series.

The lime used in this research was an air-floated high-calcium-hydrated lime [$Ca(OH)_2$] processed such that 86 percent is finer than a No. 325 sieve (0.045 mm). This lime, manufactured by the Longview Lime Company, was derived from the Newalla limestone (almost pure calcium carbonate) near Saginaw, Alabama.

LABORATORY TESTING PROCEDURES

The laboratory testing was divided into two phases. Phase 1 was designed to determine the soils' lime reactivity, as defined by Thompson. It was composed of 110 specimens, 5 with lime and 5 without lime for each soil series. The major objective was to determine whether different moisture contents for lime-treated and untreated blackbelt soil would be required to determine the lime reactivity as opposed to the more conventional approach, which uses the same moisture content for lime-treated and untreated unconfined compression strength specimens. The order of sample preparation was randomized to spread sample preparation variances homogeneously throughout the population of compacted soil specimens. Specimens prepared without lime were compacted at a moisture content 3 percentage points below the plastic limit of the natural soil. Specimens prepared with 6 percent lime by dry weight of soil were compacted at a moisture content 3 percentage points below the plastic limit of the soil treated with 6 percent lime. These compaction moisture contents are approximately the optimum moisture contents of the treated and untreated soils.

The specimens were compacted by using a Harvard miniature compaction mold and a spring-loaded kneading compaction device. The spring tension was 30 lbs and specimens were compacted in three layers by using 25 tamps per layer. Specimens were extruded, weighed, wrapped in Saran Wrap to minimize moisture loss, placed in prelabeled zip-lock bags, and cured for 48 h at 120°F (49°C). At the end of the curing period, each specimen was removed from the oven, allowed to cool to room temperature, unwrapped, reweighed to determine moisture loss during curing,

Table 1. Selected soil physical data.

Soil Series	Plastic Limit, Untreated	Plastic Limit, 6 Percent Lime	Plastic Limit Change	Sand at 2.0-0.05 mm (%)	Silt at 0.05-0.002 mm (%)	Clay at <0.002 mm (%)	Percentage Montmorillonite in Clay Fraction	Percentage Montmorillonite Based on Total Soil
Boswell	31	43	+12	14.6	26.1	59.3	69.0	40.9
Demopolis	28	34	+6	12.5	38.7	48.8	29.1	14.2
Eutaw	29	38	+9	10.1	45.1	44.8	55.8	25.0
Houston	28	36	+8	11.6	30.8	57.6	57.1	32.9
Kipling	25	35	+10	15.5	33.9	50.6	50.3	25.5
Leeper	34	38	+4	3.0	33.6	63.4	58.2	36.9
Oktibbeha	32	38	+6	4.8	35.8	59.4	51.4	30.5
Sumter	25	44	+19	14.9	36.1	49.0	41.9	20.5
Susquehanna	27	47	+20	10.3	35.6	54.1	62.8	34.0
Vaiden	35	37	+2	4.6	25.2	70.2	58.4	41.0
Wilcox	42	44	+2	13.3	29.7	57.0	77.7	44.3

Table 2. Data summary.

Soil Series	Mean UCS Untreated (lb-f/in²)	Mean UCS 6 Percent Lime (lb-f/in²)	Compaction with Untreated (%)	Compaction with 6 Percent Lime (%)	Rosser and Moore Data: Mean UCS Untreated (lb-f/in²)	Mean UCS 6 Percent Lime (lb-f/in²)	Compaction with Untreated and 6 Percent Lime (%)
Boswell	41.28	68.82	28	40	28.85	56.64	28
Demopolis	44.74	86.10	25	31	47.33	70.46	25
Eutaw	37.52	37.36	26	35	34.17	57.67	26
Houston	28.80	167.80	25	33	16.57	70.61	25
Kipling	36.50	104.52	22	32	22.26	47.89	22
Leeper	31.78	68.80	31	35	33.88	68.17	31
Oktibbeha	27.70	147.10	29	35	20.13	84.29	29
Sumter	31.84	94.22	22	41	34.40	66.25	22
Susquehanna	31.72	98.32	24	44	33.29	15.83	24
Vaiden	42.48	85.40	32	34	17.40	103.23	32
Wilcox	26.24	81.04	39	41	15.28	99.73	39

Table 3. Comparison of t-statistics with Rosser and Moore's data.

Soil Series	t-Value	Alpha Level	Rosser and Moore: t-Value	Rosser and Moore: Alpha Level
Boswell	-2.27	0.96	-3.39	0.98
Demopolis	-1.51	0.90	-4.92	0.995
Eutaw	-17.96	1.00	-3.23	0.98
Houston	5.72	0.004	0.45	0.34
Kipling	2.08	0.05	-3.07	0.98
Leeper	-1.39	0.88	-1.63	0.91
Oktibbeha	7.25	0.002	1.66	0.09
Sumter	1.90	0.07	-3.02	0.98
Susquehanna	2.93	0.02	-10.71	1.00
Vaiden	-1.23	0.86	5.97	0.003
Wilcox	1.23	0.14	4.31	0.007

and its unconfined compressive strength determined at a strain rate of 1 percent/min.

Phase 2 of this research was designed to determine the effects of different accelerated-curing laboratory procedures on the unconfined compressive strength of lime-treated blackbelt soils. Five specimens for each of the 11 soil series and for each curing scheme were prepared as outlined for phase 1. The curing schemes evaluated included 48 h at 120°F (49°C) (phase 1), 65 h at 105°F (41°C), and 75°F (24°C) for each of 7, 14, and 28 days. Since the lime-treated specimens used in phase 1 were cured for 48 h at 120°F and therefore could be evaluated as a curing scheme in phase 2, a total of 330 compacted specimens was required.

STATISTICAL CONSIDERATIONS

The statistical design for phase 1 of this research is essentially the same as that reported by Moore and Brown (3). In order to minimize random testing variations associated with repetitive strength testing of identical lime-soil specimens, a sample population composed of five lime-treated and five untreated (control) specimens was planned for each soil series. This information will allow adequate statistical significance tests to be conducted (i.e., to determine whether the means of the treated and untreated strength data sets are significantly different by more than 50 lb•f/in² with some level of confidence). Since the variances (σ_1^2 and σ_2^2) of the lime-treated and untreated specimens strength population are unknown, the modified t-test of hypothesis, which does not assume homogeneous population variances, is used.

The null and alternate hypotheses are as follows:

H_o: $(\mu_1 - \mu_2) \leq 49.99$ lb•f/in²
(soil is not lime reactive)

H_a: $(\mu_1 - \mu_2) > 49.99$ lb•f/in²
(soil is lime reactive)

The test statistic for each soil series is calculated by the formula:

$$t = [(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)]/\sqrt{(S_1^2 + S_2^2)/n} \quad (1)$$

where

n = sample size,
$\bar{x}_1$ = mean q_u of lime-treated soil,
$\bar{x}_2$ = mean q_u of untreated soil,
$\mu_1 - \mu_2$ = desired difference in means (50 lb•f/in²),
S_1^2 = sample variance in lime-treated soil, and
S_2^2 = sample variance in untreated soil.

After the t-statistic is calculated, the probability of rejecting a correct hypothesis (type 1 or alpha error) can be determined by consulting a table that presents the distribution of t with (n-1) degrees of freedom instead of (2n-2) to compensate for the effects of possible nonhomogeneous variances of the two sample populations (15). Therefore, the alpha level so determined is the probability of error associated with declaring a soil as lime-reactive based on the data presented (10 unconfined compressive strength tests).

LIME-REACTIVITY RESULTS

Ten unconfined compression tests were performed on each of the 11 soil series, for a total of 110 tests. Five of these tests were conducted on compacted specimens prepared with 6 percent lime and at a moisture content equal to the plastic limit of the lime-treated soil minus 3 percentage points. The other 5 tests were performed on compacted specimens prepared without lime and at a moisture content equal to the plastic limit of the natural soil minus three percentage points. The results of these unconfined compression tests are presented in Table 2. Also included in Table 2 are the data reported by Rosser and Moore (4). Table 3 presents a comparison of calculated t-values and corresponding alpha values for the test of hypothesis for this research effort as well as those reported by Rosser and Moore (4). The alpha levels were estimated by interpolation between 5 percent values as presented by Fisher and Yates (16). Note that, by the Thompson definition (minimum Δq_u = 50 lb•f/in²), only 4 of the soil series were judged to be lime reactive with an alpha error of 5 percent or less. However, the Houston, Kipling, Sumter, and Susquehanna series exhibit much lower alpha levels when the strength specimens are compacted at the moisture contents as outlined in this research than those reported by Rosser and Moore (4). The t-statistic and associated alpha level for six of the other seven series compare relatively well with Rosser and Moore (4).

The Vaiden series indicates a low probability of being lime reactive in this research but Rosser and Moore (4) reported a high probability that the soil is lime reactive. The reason for this contradiction in test results is not known.

The results obtained in this research indicate that a majority of the soils, which exhibited a substantial elevation in their plastic limits with the addition of lime, experience a higher probability of being lime reactive when compacted at approximately its new optimum moisture content. Therefore, the postulated moisture deficiency suggested by Rosser and Moore (4) appears to be the major reason for the absence of laboratory lime reactivity for Alabama blackbelt soil by using Thompson's accelerated-curing procedure. This finding will require that a lime-soil mixture design procedure for Alabama and Southeastern fine-grained soils based on compacted laboratory specimen characteristics specify that the compaction moisture content for the lime-treated specimens be based on an estimated optimum moisture content of the lime-treated material by using the plastic limit of the lime-treated material as a guide or on the optimum moisture content of the lime-treated material as determined by a compaction test. This requirement should be implemented for surficial soils, although the change in optimum moisture content produced during lime modification may not be significant for many soils. Note that 15 soil series were shown by Moore and Brown (3) to be lime reactive at an alpha level of 0.25 or lower by using optimum moisture contents on the basis of the plastic limits of the untreated soil for both treated and untreated compaction specimens. However, none of these soils were montmorillonitic in composition.

ACCELERATED-CURING RESULTS

Since the 55 treated samples in phase 1 of the research plan were cured for 48 h at 120°F (49°C), which is one of the accelerated-curing schemes being evaluated, only 220 additional specimens were required for phase 2. Five unconfined compression test samples for each of the 11 soil series were compacted with 6 percent lime and allowed to cure for either 65 h at 105°F (41°C), 7 days at 75°F (24°C), 14 days at 75°F, or 28 days at 75°F. An unconfined compression strength data summary is presented in Table 4.

The means of the unconfined compressive strengths of the two accelerated-curing schemes bracket the means of the 28-day ambient curing strengths as illustrated in Figures 1-4. The vertical lines on the figures represent the range of values measured. The curing period of 48 h at 120°F (49°C) consistently overestimates and the curing for 65 h at 105°F (41°C) consistently underestimates the 28-day, 75°F (24°C) cure strengths, which should be indicative of field strengths. Figures 1-4 also include data from previous research (4) that again illustrate the differences in mean unconfined compressive strengths as outlined in the preceding section and Table 3.

Also, the difference is substantial in unconfined compressive strengths for soil-lime mixtures cured at 120° and 105°F (49° and 41°C). As illustrated in Table 5, neither accelerated-curing scheme closely approximated the mixtures cured for 28 days at ambient temperature. Table 5 presents the mean unconfined compressive strengths of the lime-treated

Table 4. Unconfined compression strength data.

	48-h Cure 49°C					
Soil Series	No Lime (lb-f/in²)	6 Percent Lime (lb-f/in²)	65-h Cure 41°C, 6 Percent Lime (lb-f/in²)	7-Day Cure 24°C, 6 Percent Lime (lb-f/in²)	14-Day Cure 24°C, 6 Percent Lime (lb-f/in²)	28-Day Cure 24°C, 6 Percent Lime (lb-f/in²)
Boswell						
$\bar{X}$	41.28	68.82	53.00	44.02	54.48	66.38
S	9.95	19.75	11.57	9.45	14.10	6.16
Demopolis						
$\bar{X}$	44.74	86.10	51.37	34.38	46.14	62.38
S	9.94	7.97	3.89	3.96	4.18	5.92
Eutaw						
$\bar{X}$	37.52	37.36	25.94	19.40	25.46	35.24
S	5.35	3.22	4.42	1.91	5.08	5.04
Houston						
$\bar{X}$	28.80	167.80	125.74	79.82	117.08	155.20
S	11.14	32.96	24.59	15.44	14.58	7.58
Kipling						
$\bar{X}$	36.50	104.52	47.90	38.46	47.12	62.08
S	8.65	17.34	5.05	5.47	4.75	4.61
Leeper						
$\bar{X}$	31.78	68.80	32.94	30.34	41.16	55.72
S	7.23	19.57	6.41	7.60	12.53	8.57
Oktibbeha						
$\bar{X}$	27.70	147.10	97.64	54.84	86.80	130.20
S	6.53	20.38	6.23	10.61	7.70	23.81
Sumter						
$\bar{X}$	31.84	94.22	62.32	40.64	46.36	81.00
S	11.31	9.17	10.15	5.53	6.48	13.66
Susquehanna						
$\bar{X}$	31.72	98.32	52.18	37.74	46.14	70.58
S	7.64	10.12	6.82	3.80	9.36	4.88
Vaiden						
$\bar{X}$	42.48	85.40	48.44	41.00	38.88	65.34
S	9.51	8.58	9.15	4.17	8.46	10.02
Wilcox						
$\bar{X}$	26.24	81.04	70.30	62.04	78.16	86.10
S	1.75	8.55	17.53	4.96	24.31	12.36

Figure 1. Mean unconfined compressive strength versus time for lime-treated samples for Boswell, Demopolis, and Eutaw soil series.

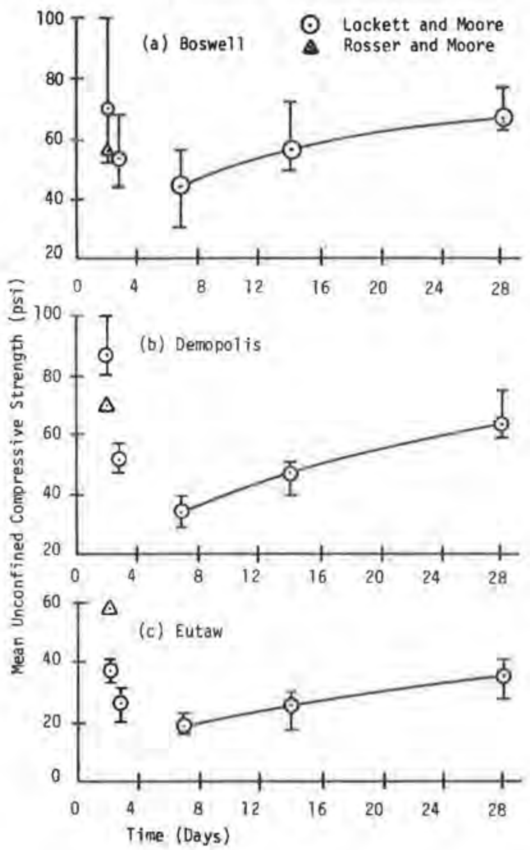

Figure 2. Mean unconfined compressive strength versus time for lime-treated samples for Houston, Kipling, and Leeper soil series.

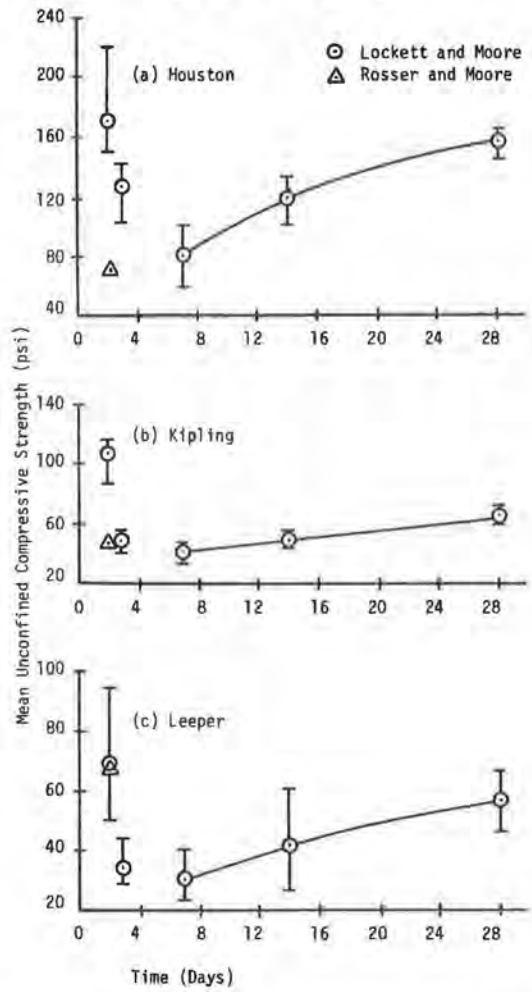

Figure 3. Mean unconfined compressive strength versus time for lime-treated samples for Oktibbeha, Sumter, and Susquehanna soil series.

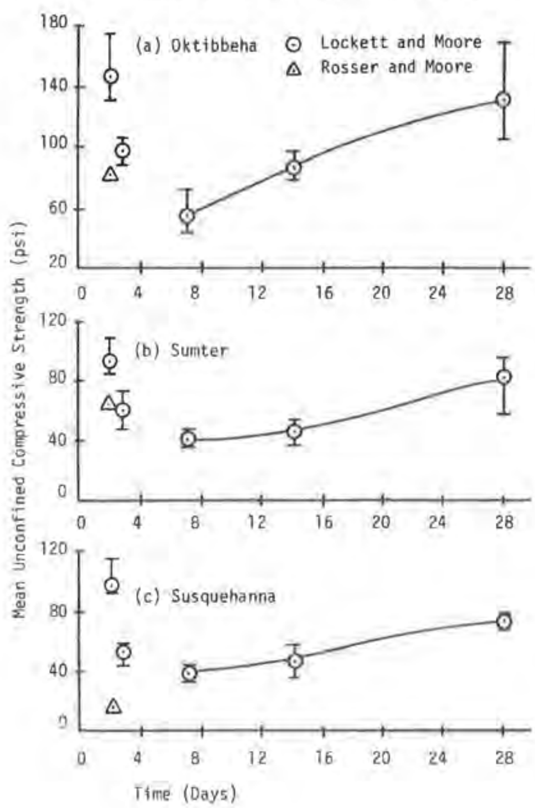

Figure 4. Mean unconfined compressive strength versus time for lime-treated samples for Vaiden and Wilcox soil series.

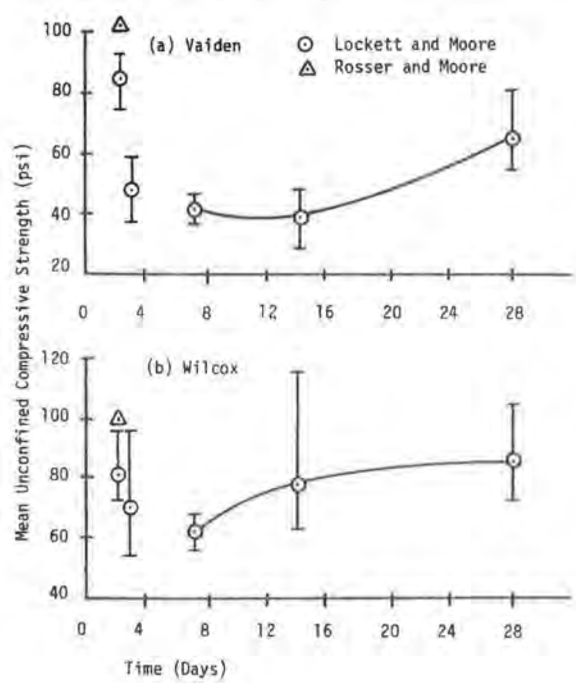

Table 5. Strength ratios by using 28-day strengths as base.

Soil Series	48 h q_u ÷ 28 day q_u	65 h q_u ÷ 28 day q_u	7 day q_u ÷ 28 day q_u	14 day q_u ÷ 28 day q_u
Boswell	1.04	0.80	0.66	0.82
Demopolis	1.38	0.82	0.55	0.74
Eutaw	1.06	0.74	0.55	0.72
Houston	1.08	0.81	0.51	0.75
Kipling	1.68	0.77	0.62	0.76
Leeper	1.24	0.59	0.54	0.74
Oktibbeha	1.13	0.75	0.42	0.67
Sumter	1.16	0.77	0.50	0.57
Susquehanna	1.39	0.74	0.53	0.65
Vaiden	1.31	0.74	0.63	0.60
Wilcox	0.94	0.82	0.72	0.91
$\bar{X}$	1.22	0.76	0.57	0.72
S	0.21	0.06	0.08	0.10

specimens cured for 48 h at 120°F, 65 h at 105°F, and 7 and 14 days at 75°F (24°C) as a proportion of the 28-day, 75°F cured strengths. The strength ratios created by the 65-h, 105°F curing period are the most consistent of the accelerated-curing schemes as indicated by the standard deviation (0.06) of the data. Note that the mean of the 65-h, 105°F accelerated-curing strengths approximate 75 percent of the 28-day, 75°F cured strengths. Also, the 65-h strengths are approximately equal to the 14-day ambient temperature strengths. Therefore, it may be possible to approximate 28-day field strengths simply by multiplying the 65-h, 105°F accelerated-curing strengths by 1.33.

CONCLUSIONS

The Thompson procedure for lime-soil mixture design should be modified when soils of the southeastern United States are evaluated. The dominance of montmorillonite in the clay fraction of some Southeastern clays, especially those of the Alabama and Mississippi blackbelt, creates the need for careful consideration of compaction moisture contents for the lime-treated specimens. The effect of lime-modification on these clays causes the optimum moisture content to increase by as much as 20 points (based on the increase in plastic limit). Therefore, the lime-treated soil must be compacted at a higher moisture content than the untreated soil. Although the different moisture contents confound the comparisons of unconfined compressive strength, the potential for moisture deficiency in the lime-treated material must be eliminated. A comparison of plastic limits for the untreated and lime-treated soil will provide an indication that the design of the lime-soil mixture will require this modification.

The use of a modified accelerated curing procedure is recommended for soils of the southeastern United States. Data developed in this research program indicate that the Thompson accelerated-curing criteria of 48 h at 120°F (49°C) overestimate the 28-day, 75°F (24°C) unconfined compressive strengths of lime-treated blackbelt soils by an average of 22 percent. A 65-h, 105°F (41°C) accelerated-curing sequence underestimates the 28-day, 75°F unconfined compressive strengths by approximately 25 percent. We therefore recommend that a 72-h (3 days is more convenient for laboratory scheduling than 65 h) accelerated-curing sequence at 105°F be employed when the Thompson procedure is used for Southeastern soils.

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