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EVALUATION OF ClaPak AND ClaSet AS SOIL STABILIZING AGENTS

MICHIGAN DEPARTMENT OF TRANSPORTATION

TESTING AND RESEARCH DIVISION
RESEARCH LABORATORY SECTION

EVALUATION OF ClaPak AND ClaSet AS SOIL STABILIZING AGENTS

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No specific formulation for ClaPak and ClaSet have been furnished nor are these materials mentioned in the patent description. In an effort to determine what we were testing and the difference between the two, samples were submitted to the Spectrochemistry and Photometry Unit of the Research Laboratory for analysis. As reported by J. T. Ellis of this Unit, analyses of the materials are shown in Table 1. These data show ClaPak to be, primarily, a strong water solution of sulfuric acid, containing about 53 percent sulfuric acid while ClaSet is, primarily, a strong water solution of about 21 percent hydrochloric acid. The pH of the whole material of each product was 0.4 or less indicating highly acidic materials. The two materials were of a different color; the ClaPak a brown-black, the ClaSet an orange.

TABLE 1
CHEMICAL ANALYSIS OF ClaPak AND ClaSet

Characteristics	Material	
	ClaPak	ClaSet
Specific gravity	1.44	1.28
pH (whole material)	< 0.4	0.4
pH (one part per 1,000 in H_2O)	2.7	3.6
pH (five parts per 1,000 in H_2O)	2.0	3.2
Free acid	52.7 percent (as H_2SO_4)	21.3 percent (as HCL)
Sulfate (SO_4^{-2})	51.9 percent	None detected
Chloride (Cl^-)	None detected	23.2 percent
Calcium	--	None detected
Iron oxide (Fe_2O_3)	--	1.2
Aluminum oxide (Al_2O_3)	--	10.0
Solids at 600 C	0.79 percent	11.7 percent
Color	Brown-black	Orange
Odor	Charred organic	None
Surface active agents	Possible, foamed on shaking	None
Infrared spectrum results	Presence of organics indicated	No organics present

Among the more important claims made for the patented agent, when applied to fine grained soils, are that it will:

1) significantly reduce plasticity index
2) substantially increase wet strength
3) eliminate frost damaged areas and soft spots
4) reduce moisture penetration
5) increase permeability of clay soils.

Field Test Sections

The site selected for the field test sections was located in the outdoor storage area of the Department's Grand Ledge maintenance garage. The layout of the control and treated sections is shown in Figure 1. Each test area measured 3 ft by 10 ft, and was constructed on a clay loam soil subgrade. The A-horizon topsoil and turf growth were stripped and the area scarified to a depth of 6 in. The chemical stabilizer solutions (and water for the control sections) were applied and the areas thoroughly mixed throughout the 6-in. depth (Fig. 2). The areas were then compacted with earth moving equipment and the surface smoothed with light rollers. This work was completed in September 1980.

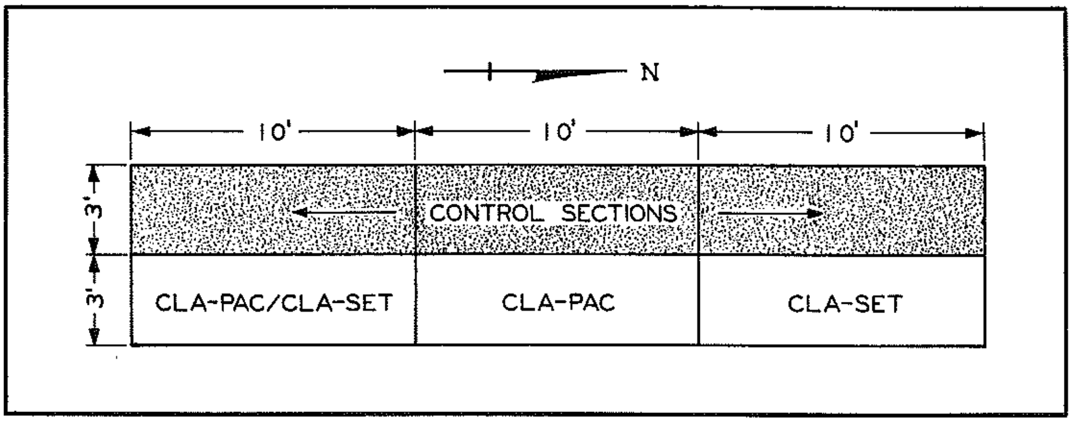

Figure 1. Layout of field test sections and controls.

The quantity and dilution of the additives were based on the literature values furnished by the producers. No specific dilution of ClaPak and ClaSet were recommended but the suggested amount varied from 200 up to 2,000 gallons of water per one gallon of chemical. A logical dilution appeared to be a ratio of 500 gallons of water to one gallon of chemical and this ratio was used. For direct comparison, an equivalent amount of water was used for the control sections. As was found in our previous testing of similar materials which required such a high dilution rate, the application resulted in a mixture above optimum compaction moisture. This resulted in densities lower than T-99 values. The field densities varied from 90 to 99 percent T-99 optimum, with the exception of one control section which was compacted to only 85 percent of optimum. Field densities were measured with the Troxler nuclear gage.

In addition to ClaSet and ClaPak, the producer's literature described the use of an equal mixture of the two materials and this combination was also included in the test area.

Figure 2. Scarified area prior to treatment.

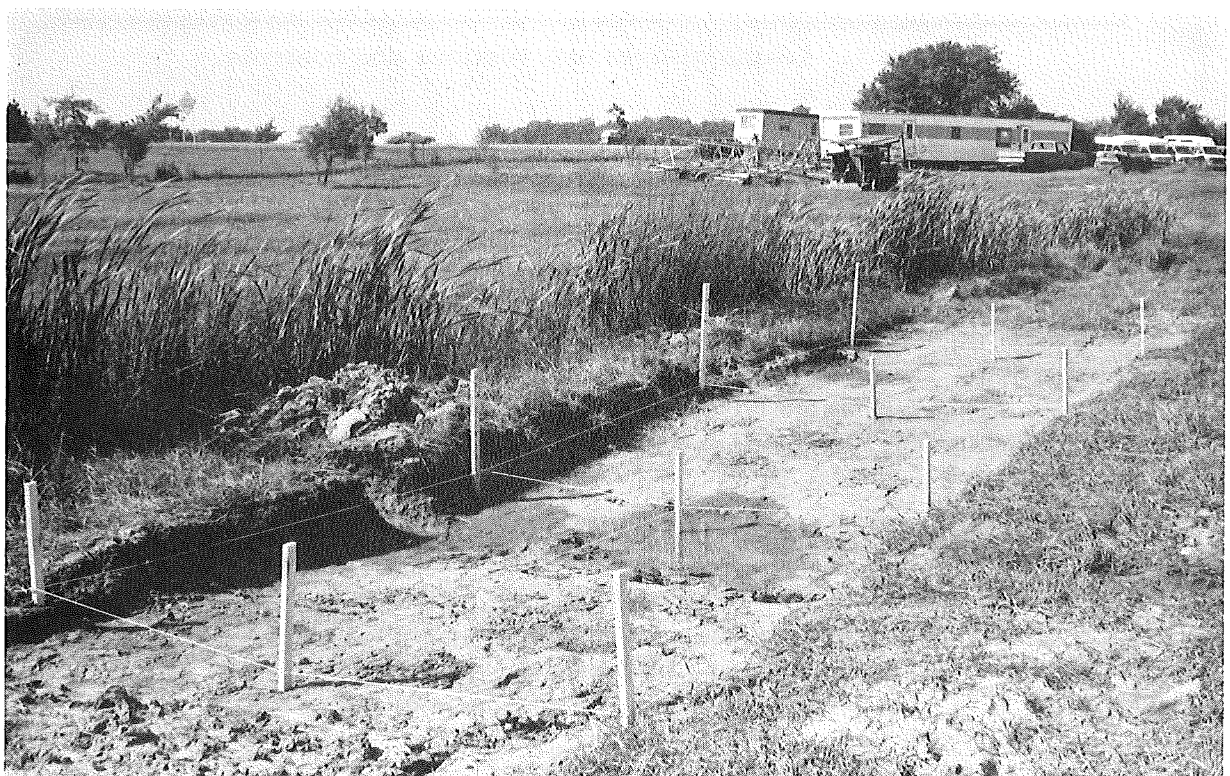

Figure 3. General view of completed test areas.

The completed test areas are shown in Figure 3. The moist area represents a low spot drained by a ditch. This portion of the test area was not included in subsequent tests but was used to determine any effects the two chemicals might have on permeability and drying characteristics of the soil. Both chemical treatments and a control area are included in this portion of the test area.

The test areas were allowed to set for a period of one month and were then inspected and tested for load bearing capacity. The surface of all the test sections showed considerable shrinkage cracking following a heavy rainfall shortly after construction (Fig. 4). This condition occurred only at the surface of the compacted material and continued during drying periods throughout the life of the project. When damp, the areas appeared as in Figure 5.

An index of the bearing capacity of the test sections and controls was obtained by the use of a pocket penetrometer (Fig. 6). Values obtained in these tests, shown in Figure 7, are relative and highly dependent on moisture content at the time of testing. This figure also shows how the loose surface was scrapped away to obtain a level, more firm surface for placing the penetrometer foot. Penetration values were obtained at one year intervals in 1980, 1981, and 1982. The individual test points represent the average of five measurements throughout each test plot. The average and range of values obtained for the three control areas are shown in order to indicate variation in the untreated soils, and provide a meaningful base for measuring any changes caused by the treatments. The results of the penetration tests indicate no significant differences between the treated sections themselves or between the treated sections and the untreated. This was obvious also by visual inspection of the areas where no effect of the treatments was apparent. At no time during the test period were there any indications of bonding or water resistance of the treated materials nor any difference in the wetting, drying, or drainage characteristics. All during the test period the test areas were quite soft when damp or loosely bound when dry, and could be easily dug into, as shown in Figure 8.

Laboratory Test Results

Although the primary purpose of this project was to determine field performance of the chemical treatments, laboratory studies were made to supplement the field work and, possibly provide a better interpretation of the results. Samples were taken from the treated area and the three control sections for the laboratory study.

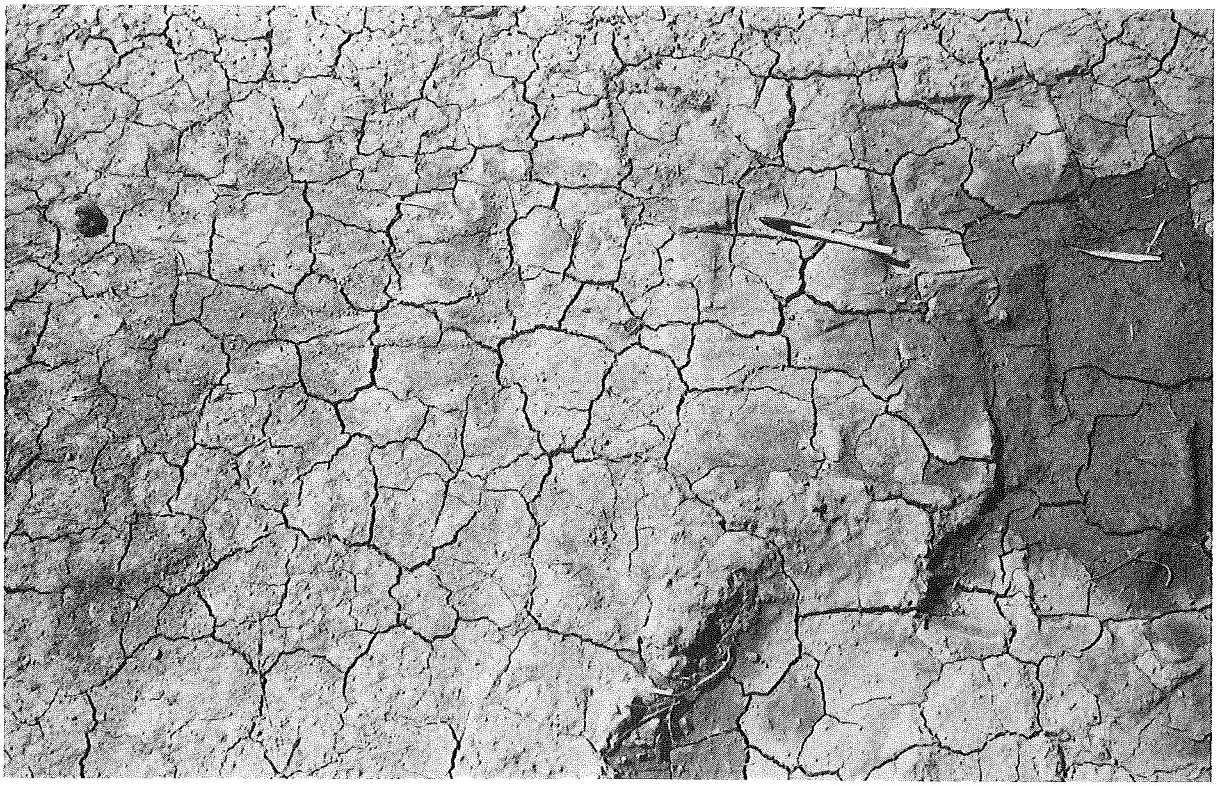

Figure 4. Typical shrinkage cracking after one month exposure (ClaPak section shown).

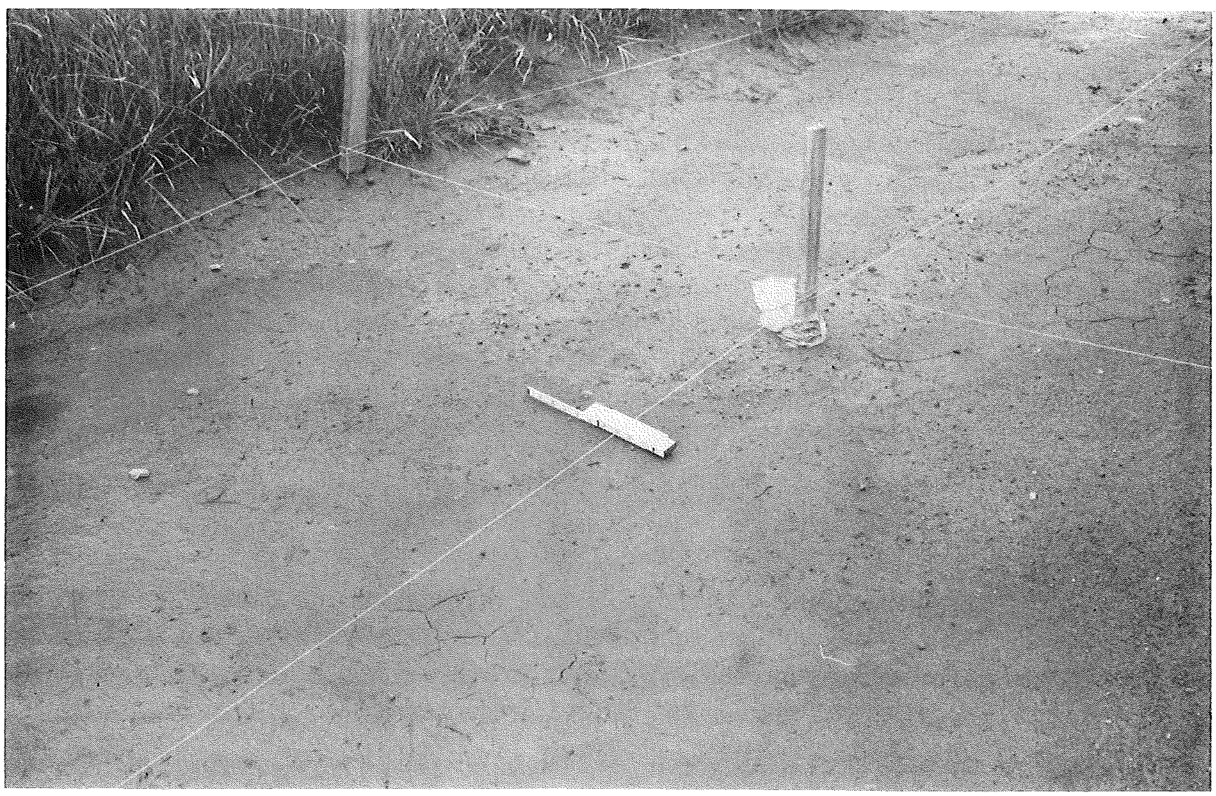

Figure 5. Appearance of test sections when moist.

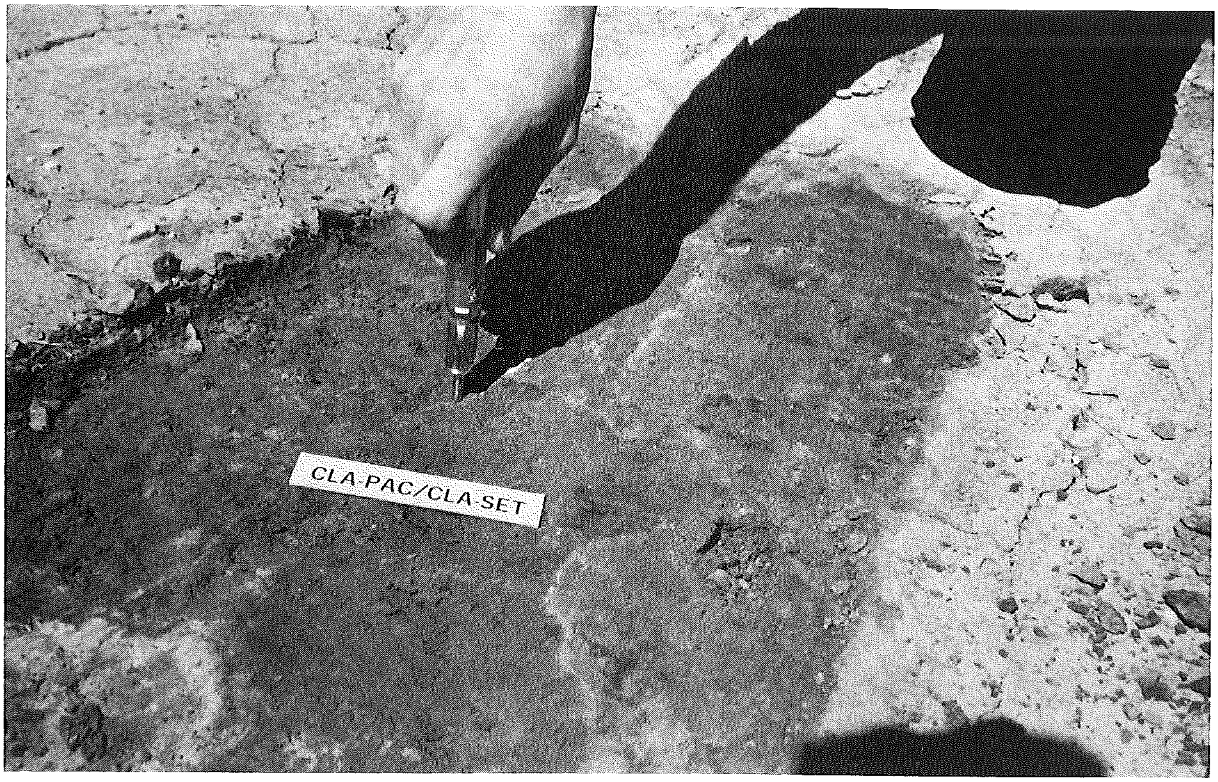

Figure 6. Penetration testing of the test areas.

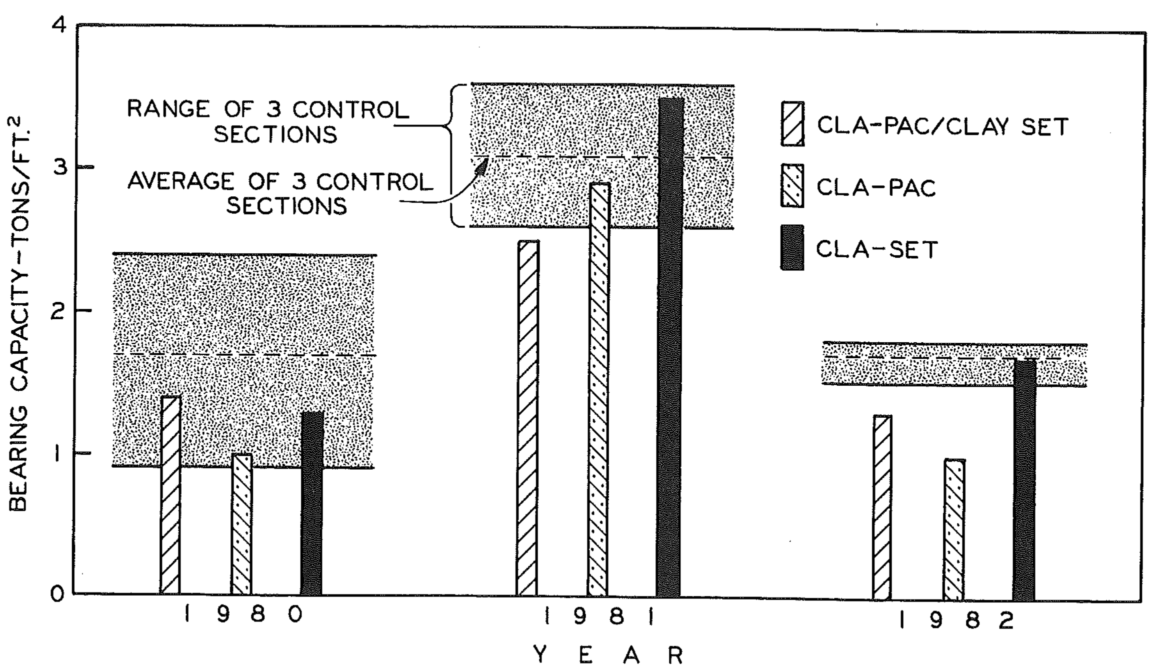

Figure 7. Bearing capacity of the control and test sections (soil penetrometer).

The grain size analysis of the treated and untreated materials, shown in Table 2, indicate no significant change in the sand, silt, or clay content due to the addition of the chemicals.

TABLE 2
GRAIN SIZE ANALYSIS OF THE TEST SECTIONS, PERCENT

Section	Sand	Silt	Clay
Control No. 1	41	40	19
Control No. 2	39	41	20
Control No. 3	38	42	20
ClaPak/ClaSet	39	42	19
ClaPak	41	40	19
ClaSet	38	38	24

Figure 8. Showing lack of bonding of the test areas.

In order to test the effect of the chemical treatment of the compaction characteristics of the treated soil controlled laboratory T-99 density tests were made on treated and untreated samples. The test results shown in Figure 9 indicated no increase in density values due to the chemical treatment, all being within or below the range of values obtained for the control samples.

Unconfined compression tests were made to determine strength of the treated and the control samples. For these tests 4 by 8 in. samples were molded at optimum moisture and cured in airtight plastic bags for 30 days prior to testing. The compressive strength values, shown in Figure 10, show no significant change in strength due to the treatments, all treated values falling within the range of the control values.

Figure 11 shows results of capillary moisture absorption tests in which 4 by 8 in. samples were air dried to constant weight, placed on a porous base plate and subjected to moisture intake through the bottom of the sample. Both the treated and control samples absorbed moisture rapidly, at the same rate, until they could no longer support their own weight. No waterproofing characteristics could be noted for any of the treatments.

As shown in Table 3, no significant changes in the plastic characteristics of the natural soil were made by the addition of the chemicals.

TABLE 3
PLASTICITY CHARACTERISTICS

Treatment	Liquid Limit	Plastic Limit	Plasticity Index
Control	31.2	21.1	10.1
ClaPak	30.1	19.5	10.6
ClaSet	31.0	20.2	10.8
ClaPak/ClaSet	30.0	19.1	10.9

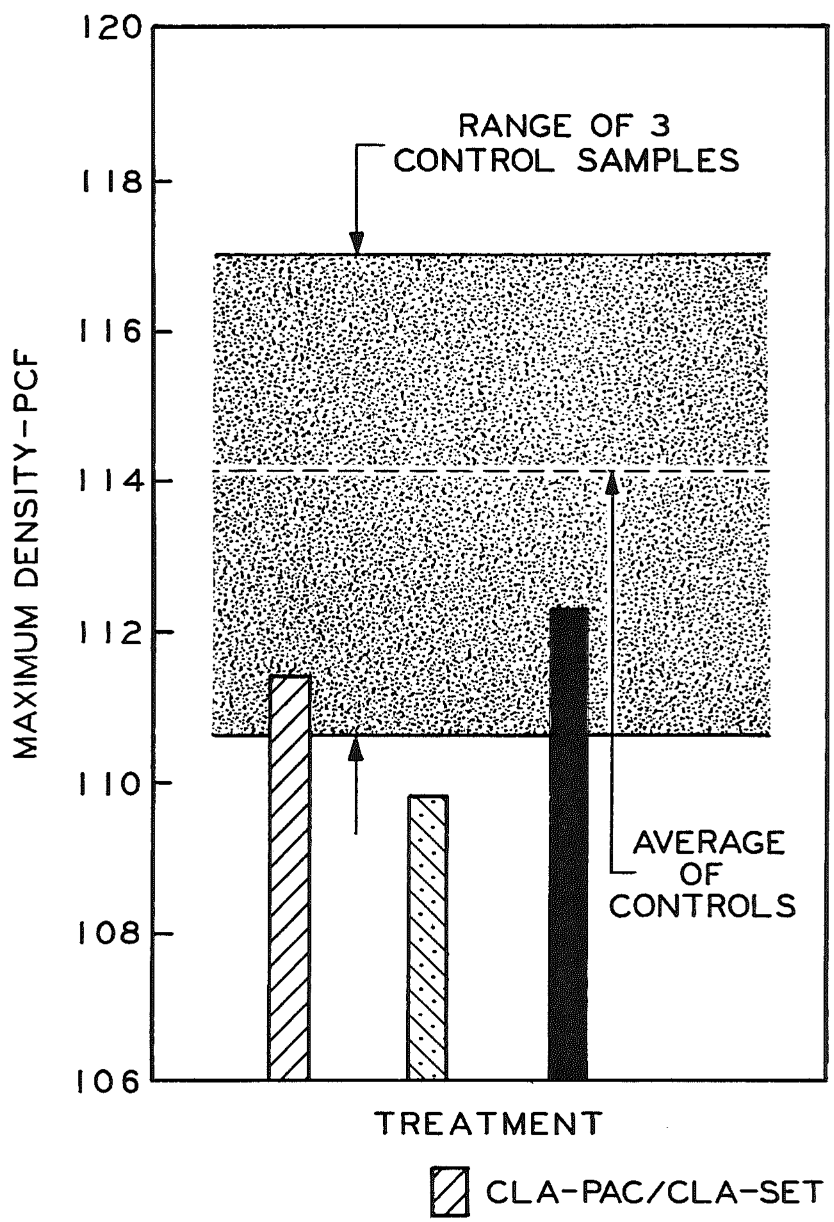

Figure 9. T-99 compaction test results.

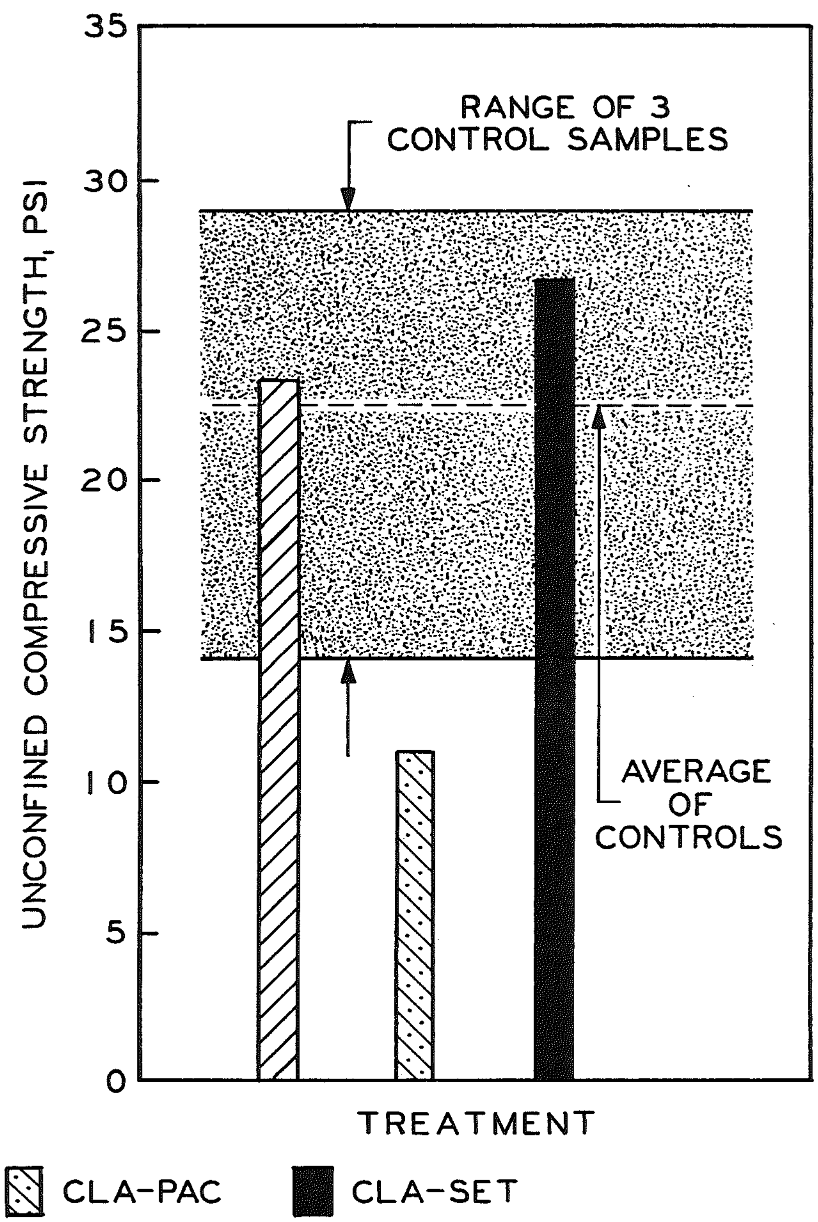

Figure 10. Unconfined compressive strength values, laboratory samples.

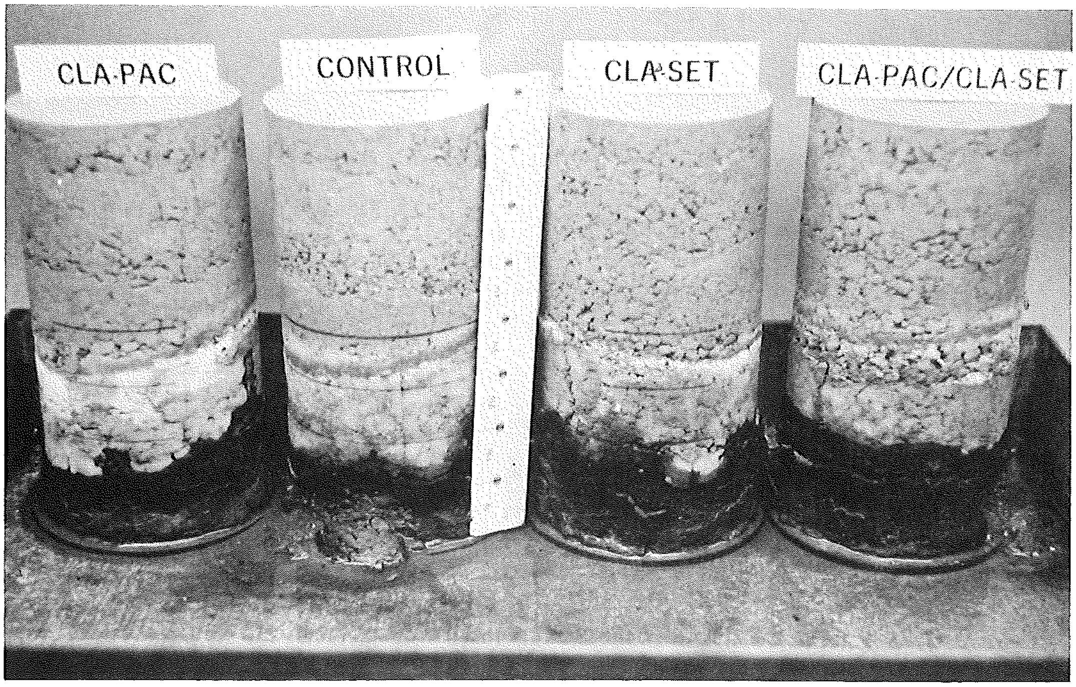

Figure 11. Capillary moisture absorption test, laboratory samples.

Conclusions

As a result of small scale field testing and supplemental laboratory evaluations conducted during this study, it is indicated that the addition of ClaPak, ClaSet, and equal mixture of these two materials, produced no significant changes in the engineering properties of a clay loam soil. Strength, moisture intake resistance, compaction and plasticity characteristics of the soil remained unchanged by the treatments. In fact, when applied in the dilutions recommended, the additives had no more effect on the soil than would the addition of water alone.

Results of this study confirm the findings of previous testing by the Department in which similar materials, under different designations, were evaluated (1) and rejected for construction use. It is recommended that ClaPak and ClaSet also be given no further consideration for use by the Department as a soil stabilizing agent.

REFERENCE

1. Mainfort, R. C., "Evaluation of Paczyme as a Soil Stabilizing Agent," MDOT Research Report No. R-734, April 1970.