REACTIVITY OF CLAYEY SOILS WITH HYDRATED LIME

by

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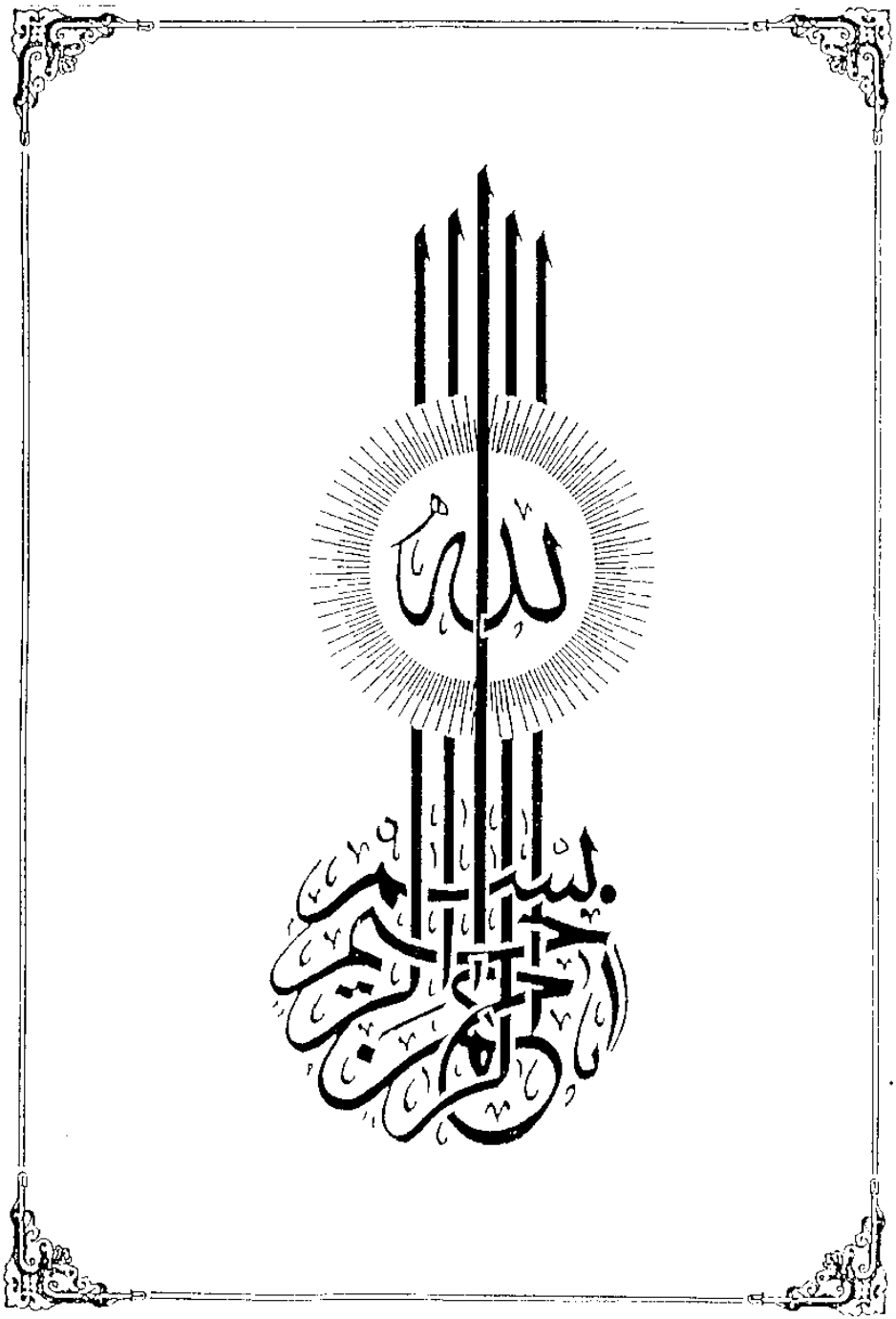

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ABSTRACT

The main objectives of this investigation are to study the factors influencing the reactivity of lime with some of the Egyptian soils, and to explain in terms of lime-soil reactions the effect of these factors on lime-soil reactivity. The factors that affect the response of soils to lime are : soil type, lime type, percentage of lime and curing conditions.

The scope of this study was limited to eight different soil samples representing some of the Delta and Nile Valley soils. One commercial type of lime, which is available in Egypt, was used at different percentages when treating soils.

Soil samples were extensively analyzed to determine their selected physical, chemical and mineralogical properties. Proper quantities of lime (three, five, and seven percent), and air-dried soil were thoroughly blended, then the amount of water required to bring the lime-soil mixture to optimum moisture content was added, and mixing continued. Specimens of the natural soils and lime-treated soils were compacted at approximately optimum moisture content as determined by a moisture-density relationship. This test was conducted in a manner similar to AASHO T_{99-57} except

that 4-inch mold, 2-inch in diameter was used. Specimens were molded in three equal layers, with each layer receiving a compactive effort of 20 blows of a 4-pound hammer, dropping 12 inch. After proper trimming, the specimens were extruded and cured. Curing at an elevated temperature of 140° F. was made by placing the specimens in an electrical oven provided with an automatic temperature control. The effect of curing temperature was studied at 70 and 140° F. The effect of curing period was studied only for one soil sample, using five percent lime for 3, 7, 14, 21, 35 and 53 days. At the termination of the curing period, the unconfined compressive strength of the specimens was determined.

Statistical techniques were used in analyzing the experimental data, and the results were discussed in correlation with the variables affecting lime-soil reactivity. The discussion led to the following conclusions :

1- Strength increase of lime-soil mixtures occurs if the percentage of organic carbon is less than one percent.

2- The percentage of clay less than two microns necessary for significant increase in strength varies from 20% to 30%.

5- The [illegible] lime to drive soil should be [illegible].

4- Montmorillonitic or Kaolinitic soils respond better to lime treatment than illitic and chloritic soils.

5- Increasing the lime content of a lime-soil mixture causes an increase in the strength up to a certain lime content, beyond which the strength will decrease. The optimum lime content was related to soil pH. Soils having low pH values required large quantities of lime and vice versa.

6- The strength of lime soil mixtures increases with time. The curing temperature affected the rate of increase in strength of the lime-soil mixtures. The accelerated curing at 140° F. for seven days can be used to predict the 28-day strength of a lime-soil mixture at 70° F.

7- Increasing the lime content causes an increase in the dry density of the lime-soil mixture up to a certain lime content beyond which an increase in lime percentage does not necessarily produce an increase in dry density.

CHAPTER I

INTRODUCTION

1.1. General

No doubt that the size of the present highway programme (Table 1) makes it essential that sufficient scientific methods for evaluation, design and construction of highway pavements be developed and put into use. The scientific approach must be used in the evaluation of new materials which are not currently being used in the highway field in order that these new products may be effectively incorporated in the production of strong, durable and economical highways.

Since the beginning of modern road construction, highway engineers have striven continuously to produce better pavements at lower costs. It often has been found difficult to obtain suitable base or subbase materials within reasonable hauling distances of construction projects. Highway engineers are continually confronted with the problem of improving the load carrying capacity of natural soil.

Numerous methods of soil stabilization have been used in the past, and new methods are being continually developed. One successful method is the stabilization of locally available soils with a binder material. Increased interest has been shown in lime lately as one of these binders. If the addition of a small percentage of lime can improve the in-place subgrade or bring a nearby borrowed material within the limits of specifications, economy will result. It is relatively inexpensive and can often be used to produce both a chemical change and a cementing action that will improve the soils.

1.2. Lime Production in Egypt

Lime is produced in Egypt as one of the building and construction materials. It is manufactured by heating the crushed limestone to above 2000° F in rotary kilns. According to Abd-El-Kareem Ata, (1967), the limestone exists in an area which extends to the East and South of Cairo (Mokattam, Athar-El-Nabi, Torah and Helwan).

The ninth annual statistical handbook of the Central Agency for Public Mobilisation & Statistics, (1971), shows that the production of lime in Egypt is increasing to meet the consumption requirements, (Table 2).

1.3. Purpose and Objectives of Study

Egypt has large areas, particularly North of the Delta, where the subgrade and embankment soils used in the construction of highways are highly plastic, and poor in the load supporting capacity, when being wet. According to El-Mekawi, (1961), the majority of subgrade soils in the area from the middle zone of the Delta to the East or to the West follow the A-7 group of the AASHO classification, till the transition zones near the deserts. There, the A-6 plastic soils and the A-4 non-plastic soils exist. Also, the subgrade soils in the area from Cairo to Assiout follow the A-7 group. South of Assiout, the A-6 and A-4 soils appear to represent the soil of the River Nile Valley.

The purpose of this study is to evaluate the reactivity of some of the Egyptian clayey soils with lime as a stabilizing agent.

The main objectives of the investigation are :

1- To study the factors influencing the reactivity of lime with some of the Egyptian clayey soils.

2- To explain in terms of lime-soil reactions the effect of these factors on lime-soil reactivity.

1.4. Scope of Investigation

This study was limited to eight different soil samples representing some of the Delta and Nile Valley soils. One commercial type of lime was used at different percentages for treatment of soils.

The study consists of a review of literature and a laboratory testing program, to evaluate the variables that influence the response of soils to lime. Statistical techniques were used in analysing the experimental data, and the results were discussed in correlation with these variables affecting lime-soil reactivity. The discussion led to some conclusions concerning the applications of lime-soil stabilization in the field of highways constructed on such soils.