Effect of Curing on Soil Stabilized with Egg Shell

Karthika Prasad
Department of Civil Engineering
Amal Jyothi College of Engineering, Kanjirapally

Nissy Mathachan
Department of Civil Engineering
Amal Jyothi College of Engineering, Kanjirapally

Prabhu P James
Department of Civil Engineering
Amal Jyothi College of Engineering, Kanjirapally

Tess Liya Justine
Department of Civil Engineering
Amal Jyothi College of Engineering, Kanjirapally

Abstract

Clayey soils are widely used for most of the construction projects. They are soft soils and have good plastic properties so that increased moisture results in their decreased shear strength, compressive strength and volume changes. Considering millions of tons of waste produced annually across the country, which not only poses the problem of disposal but also adds to environmental contamination and health risks, utilization of such refuse and industrial wastes and their subsidiary products as alternatives to construction materials may effectively contribute to environmental preservation and minimization of their adverse effects on the environment. In the present study, eggshell powder was used as waste, to combine with soil so that the properties of clay soil were investigated in different mixture proportions. This study is aimed at determining the increase in unconfined compressive strength of kuttanad clay, by testing it after placing the sample for a curing period of 0 ,4 ,7 days. Curing period refers to the time period between the point of making the mould and finally testing it. Also the geotechnical properties and volumetric shrinkage strain of Kuttanad clay were tested in this study. From this study, eggshell powder can be used to significantly improve the strength of soil. The result of unconfined compressive test with eggshell as an stabilizing agent at varying percentage (10%, 15%, 20%) after 0, 4, 7 days each showed that the strength increases at 15% after 7 days curing which is the optimum value and reduces at 20%. For each value of optimum moisture content determined from the standard proctor test a sample was prepared using the same proctor mould after compacting each layer, after which it was extruded out of this mould and its dimensions were measured. The change in the dimensions was noted after a period of 4, 7 days. Minimum volume change was observed at 15% which is found to be the optimum percentage.

Keywords: Unconfined compressive strength, volumetric shrinkage strain, eggshell powder

I. INTRODUCTION

A difficult problem in Civil Engineering work exists when the sub-grade is found to be clay. Soils having high clay content have a tendency to swell when their moisture content is allowed to increase. One of the various techniques for improving the soil properties is soil stabilization.

Soil stabilization is a technique aimed at increasing or maintaining the stability of soil mass and chemical alteration of soils to enhance their Engineering Properties. Stabilization can be used to treat a wide range of subgrade materials from expansive clay to granular materials. This allows for the establishment of design criteria as well as the determination of the proper chemical additive and admixture rate to be used in order to achieve the desired engineering properties. Benefits of the stabilization process can include higher resistance values, reduction in plasticity, lower permeability, reduction of pavement thickness, elimination of excavation material hauling or handling. Stabilization of expansive soils with admixtures controls the potential of soils for a change in volume, and improves the strength of soils.

In this project egg shell powder was added to Kuttanad clay, its geotechnical properties and curing effects after adding different percentage of eggshell were studied.

II. SCOPE AND OBJECTIVE

Soil stabilisation is done essentially to prevent cracking and breaking up of pavements, railways, highway embankments, roadways, foundations and channel or reservoir linings. It helps in reducing the cost of repairing the damaged structures and to eliminate or reduce the effect of volume change in the soil thus preventing structure subsidence. By using waste products in Kuttanad clay stabilisation it not only increases the soil stability and strength but also serves as a method of waste disposal.

The objective of this project is to test the basic properties of Kuttanad clay, to study the improvement on the properties of clayey soil with addition of egg shell powder and to study the effect of curing on Unconfined Compressive strength (UCC) and Volumetric shrinkage strain (VSS) on Kuttanad clay stabilized with different percentages of egg shell powder.

III. METHODOLOGY

A. Component Materials:

Component materials for concrete mixtures were:

- Kuttanad clay
- Egg shell powder
- water

1) Kuttanad Clay

Kuttanad clay used for the study was collected from Allepey district. Kuttanad clays are dark brown coloured medium sensitive alluvial deposits spread over the Kuttanad region in the state of Kerala in India. This area lies 0.6-2.2 m below mean sea level and a major portion of the region is in submerged condition during the monsoon season in every year.

The dominant mineral constituents in this clay are kaolinite and illite. These clays are characterized by high compressibility, low shear strength and high percentage of organic matter, which are unfavourable from the geotechnical point of view. A large number of embankment failures and foundation failures have been reported in this soil due to its poor shear strength and compressibility characteristics. This property results cracks in soil without warning .These cracks may sometimes extend to severe limits.so buildings to be constructed in the soil may suffer severe damage with the change of atmospheric pressure .The engineering properties of the soil were determined by standard procedures specified by Bureau of Indian Standards.

2) Egg Shell Powder

Eggshell, preferably the chicken eggshell perceived a waste material could be annexed for the use as a replacement for soil stabilizer like lime since they share the same chemical composition. The use of stabilization agents like lime and bitumen proves expensive and requires an economic replacement. The eggshell primarily contains lime, calcium and protein. It has been in use as a source of lime in agriculture, which confirms that lime is present in considerable amount in eggshell.

Most good quality eggshells from commercial layers contain approximately 2.2 grams of calcium in the form of calcium carbonate. About 95%of the dry egg shell is calcium carbonate weighing 5.5 grams .The average egg shell contain about 0.3% of phosphorous about 0.3% of magnesium and traces of sodium, potassium, zinc, iron and copper .The organic material has calcium binding properties, and its organization during shell formation influences the shell. The majority of the true shell is composed of long columns of calcium carbonate .There are other zones that are involved in the self-organization giving the eggshell its strength properties.

3) Water

Water used for mixing was potable water, which was free from any amounts of oils, acids, alkalis, sugar, salts and organic materials or other substances that may be deleterious to soil.

IV. RESULTS

Property	*Values Obtained*
Specific gravity	*2.6*
Liquid limit	*49%*
Plastic limit	*27%*
Shrinkage limit	*25.36%*
Percentage of clay	*26%*
Percentage of silt	*50%*
Percentage of sand	*24%*
Plasticity Index	*22%*
IS Soil classification	*CI*

A. Standard Proctor Test Results:

The OMC for soil samples were done with different proportions of egg shell powder added to it. It is seen that the OMC decreases with increase in egg shell powder (ESP) content and the dry density is increases with the increase in ESP content. The values of OMC and dry density for different ESP proportions are given in table 4.1.1. The bar chart showing its variation is shown in figure 4.1.1. And 4.1.2 respectively. The individual observation tables for virgin clay, with 10%, 15%, 20% are shown in table.

Table - 4.1.1
Results obtained from Proctor Test

Percentage of eggshell added (%)	*Optimum Moisture Content (%)*	*Max. Dry Density (g/cc)*
0	*33.33*	*1.35*
10	*23.8*	*1.518*
15	*21.4*	*1.52*
20	*26.136*	*1.49*

The results obtained are tabulated in Table 4.2.

Optimum Moisture Content is 21.4
Maximum Dry Density is 1.52

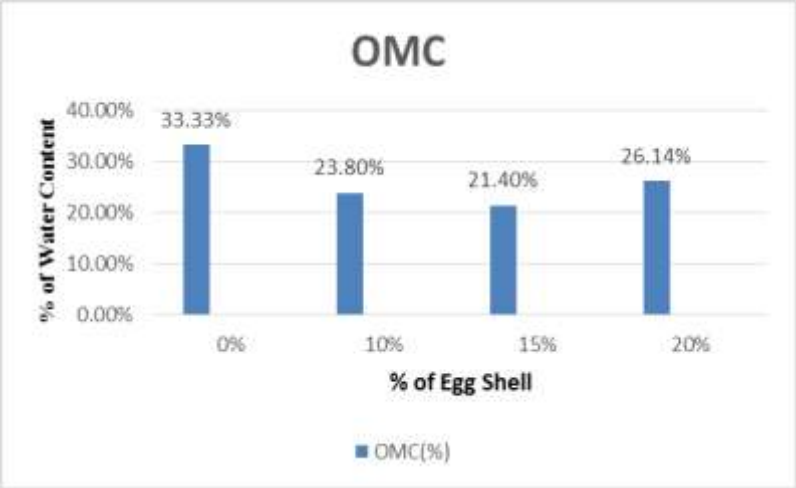

Fig. 4.1.1: Bar Chart Showing Variation in OMC

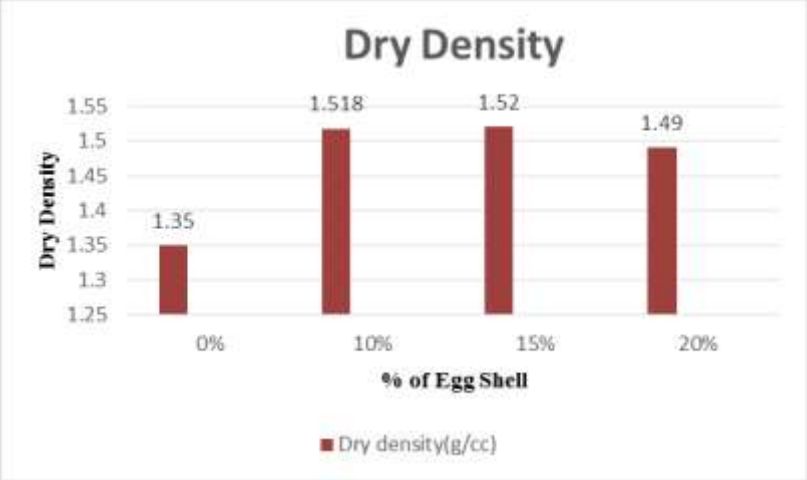

Fig. 4.1.2: Bar Chart Showing Variation in Dry Density

B. UCC Test Results:

The unconfined compressive strength values for different ESP proportions are given in table 4.2.1 and figure 4.2.2. is the bar chart showing its variation? As the amount of ESP is increased in the soil the UCC value get increased up to a particular limit (15%). After 15% the UCC value is decreased. The UCC test was conducted on the sample after keeping it undisturbed for a curing period of 0, 4, 7 days after its preparation. From the tests it was seen that the maximum UCC value was obtained after a 7 day curing period of 15% ESP added sample.

Table - 4.2.1
UCC Values with Different ESP Proportions

Percentage of egg shell added (%)	*UCC Values (N/mm²)*		
	0 day	*4 day*	*7 day*
0	*22.274*	*32.942*	*54.9*
10	*27.461*	*44.506*	*184.843*
15	*33.321*	*57.608*	*196.311*
20	*15.664*	*48.975*	*53.294*

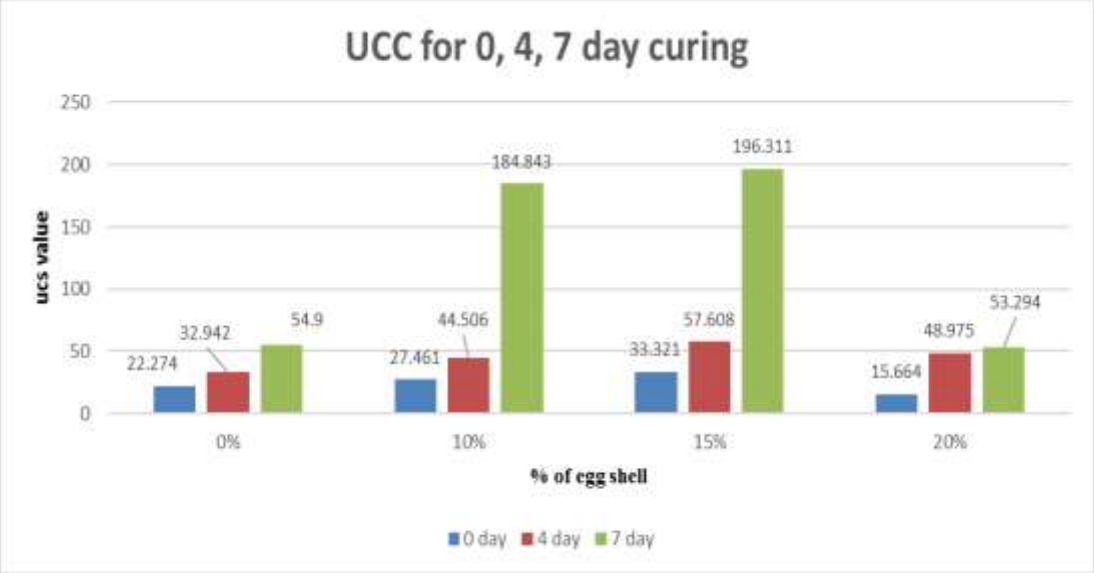

Fig. 4.2.1: Bar Chart Showing Variation in UCC Value

C. *Volumetric Shrinkage Test Results:*

The volumetric shrinkage values for different ESP proportions for 0, 4, 7 day curing is given in table 4.3.1and figure 4.3.1 is the bar chart showing its variation. As the amount of ESP is increased in the soil the volume change reduces to a particular limit (15%). After 15% the volume change increases. The volumetric shrinkage test was conducted on the sample after keeping it undisturbed for a curing period of 0, 4, 7 days after its preparation. From the tests it was seen that least volume change was obtained at 15 % ESP added sample.

Table - 4.3.1
Volume of Specimen for Different ESP Proportions

%EGG SHELL	*Volume (cm^3)*		
	0 day	*4 day*	*7 day*
0%	*942.87*	*888.63*	*859.563*
10%	*962.211*	*894.167*	*877.659*
15%	*973.894*	*927.785*	*910.875*
20%	*969.416*	*913.764*	*890.302*

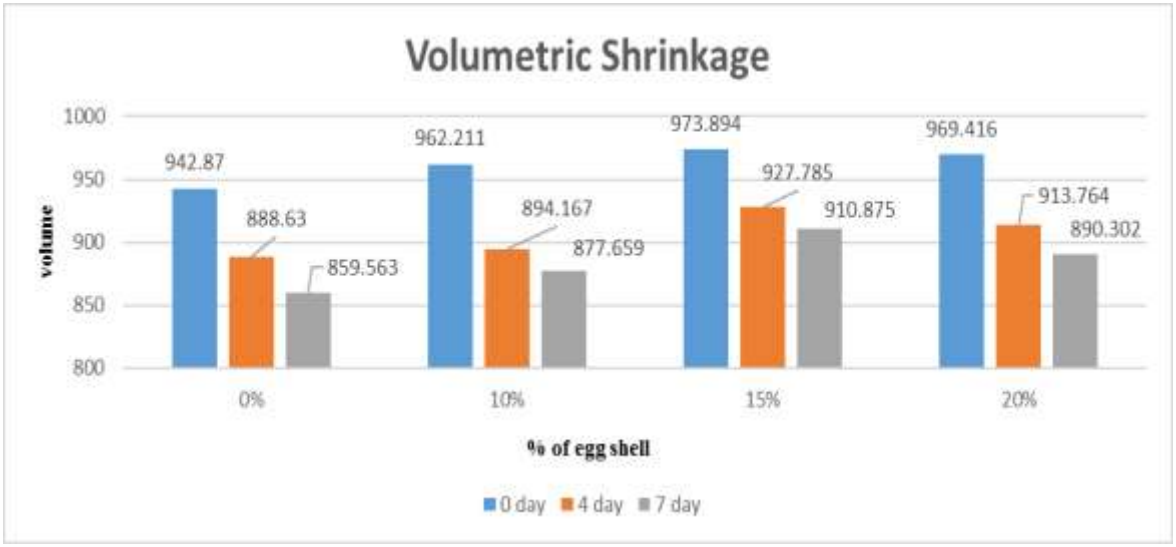

Fig. 4.3.1: Bar Chart Showing Variation in Volume

D. *Volumetric Strain Results:*

The volumetric strain values for different ESP proportions are given in table 4.4.1 and figure 4.4.1sssssssss is the bar chart showing its variation. As the amount of ESP is increased in the soil the volumetric strain reduces to a particular limit (15%). After 15% the volumetric strain increased.

Table - 4.4.1
Volumetric Strain Values for Different ESP Proportions

%EGGSHELL	*VOLUMETRIC STRAIN (%)*
0	*8.8*
10	*8.7*
15	*6.4*
20	*8.1*

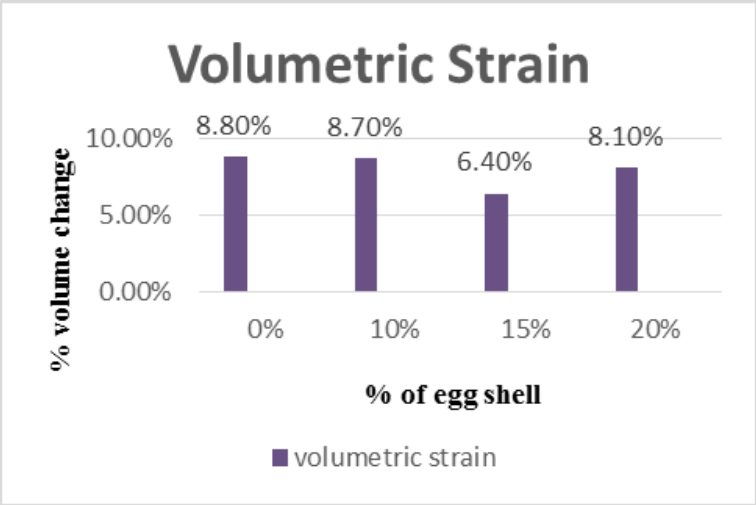

Fig. 4.4.1: Bar Chart Showing Variation in Volumetric Strain

From the above results and discussions we can summaries that the ESP can be used as reinforcement and stabilizing agent for soil. When ESP is added to the soil the optimum moisture content decreases and the dry density increases. An increase of 196.311 in UCC value and least volume change was obtained at 15% of ESP. The optimum value for UCC is obtained at 15%.

V. CONCLUSION

The following conclusions can be drawn from the study conducted.

- OMC decreases and maximum dry density increases with increase in percentage of eggshell powder.
- The optimum moisture content of virgin soil was 33.3% which is then gradually decreased to 21.4% at 15% of eggshell powder and then increases to 26.13% at 20% egg shell powder.
- Compressive strength of clay increases with increase in eggshell powder upto 15%and then the value decreases with further addition of eggshell. The initial increase in the unconfined compressive strength (UCS) value was expected because of the gradual formation of cementitious compounds (calcium silicate hydrate) due to the reaction between the calcium carbonate present in the eggshell powder, soil and water. The decrease in the UCS values after the addition of 20% eggshell powder was attributable to excess eggshell powder that occupies spaces within the soil to form weak bonds between the soil and the cementitious compounds formed by reaction, thus having a negative effect on the cohesive nature of the soil. The increase in strength at 7 days was due to the pozzolanic reaction between soil and eggshell powder.
- From the analysis it is obtained that 15% of eggshell powder gives considerable improvement in properties of clay soil. So 15% selected as optimum percentage.
- Volumetric shrinkage decreases with increase in percentage of eggshell powder. Volume changes in clay occur due to variation in moisture content. As the percentage of ESP is increased the volume changes decreases, at 15% a maximum dry density was obtained which was found to be much greater than the dry obtained at 20% ESP. this increase in the dry density prevents the further swelling of water molecules around the soil particles and hence provides a lesser change in volume. Hence we can conclude that 15 % is the optimum value of ESP.

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