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Stabilization of Clay Soil using Egg Shell Powder and Quarry Dust

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Abstract : Soil is one of the most important materials used in a variety of construction project including earth work and earth dam. The clay soil reveals high strength in dry condition, but exhibit low strength in wet condition. Thus variation in the characteristic behavior of the clay soil result major problem in the engineering properties during construction. So many different approaches are made in order to improve the soil characteristics stratum. Quarry dust exhibit high shear strength for the benefit of Geotechnical material. Egg Shell powder composition is similar to that of lime so it increases the soil stabilization. In this project sample of clay in Neelambur (Coimbatore) made the basic test for that soil sample. After analyzing the properties from the sample, Quarry dust has been replaced in proportion of 10%,20%,30%,and 40% and Egg Shell Powder has been added in proportion of 20%(constant). The laboratory tests are conducted in Geotechnical properties. By adding Egg Shell Powder and Quarry dust the behavior of the Engineering property is improved. From the investigation of this project is the combination of Quarry dust and Egg Shell Powder is more effective than the addition of Quarry dust or Egg Shell Powder alone for the improvement of the properties of clay soil.
Keywords : Clay Soil, Egg Shell Powder, Quarry dust, Stabilization.

1.0 Introduction

For any land-based structure, the foundation is very important and has to be strong to support the entire structure. In order for the foundation to be strong the soil around it plays a very critical role. So, to work with soils, we need to have proper knowledge about their properties and factors which affect their behaviour.

Soil stabilization is a process whereby natural or synthetic materials are added to soil improving soil properties. It is typically used to modify and improve low-quality materials, which brings about changes in soil properties including decreased rate of subsidence, decreased adhesion coefficient in soils with high cohesion (clay), increased adhesion coefficient in soils with low cohesion (sand), reduced percentage of water absorption and prevention of soil expansion, reduced cost of earth structures (transport), speeded road construction operations, resistance to frost and defrost, improved ductility, reduced rigidity of earth structures, lack of weed growth in the surface of earth structures such as roads and reduced thickness of bearing layer. One of the most common methods of fine soil improvement is to stabilize it using additives that improve soil properties through physical and chemical changes. It is, however, worth noting that fine soils behavior should be well studied before deciding on the method of improvement. Soil modification or stabilization is usually carried out to achieve the following goals:

- Increasing soil strength, geotechnical properties and bearing capacity

- Preventing structure subsidence
- Reducing adhesion in highly adhesive soils
- Increasing adhesion in soils with low adhesion (sands)
- Increasing safety factor against slope, levees and earth dam sliding
- Reducing soil plasticity index

In the present study, Egg Shell Powder (ESP) and Quarry Dust (QD) were used to study the effect on the properties of clayey soil. An improvement in the strength properties of soil by addition of ESP and QD will help to find an application for waste materials to improve the properties of clayey soil and can be used as a better stabilizing agent.

2.0 Objective of This Study

The aim of this work is to study the improvement on the properties of clayey soil with addition of Egg Shell Powder and Quarry Dust at varying percentages.

3.0 Literature Review

3.1 AMU.O.O

amu.o.o studied the effect of egg shell powder on the stabilizing potentila of lime on an expansive clay soil.He conducted series of test to determine the optimalpeecentage of lime – egg shell powder combination.The optimal quantity of lime was gradully replaced with suitable amount of egg shell powder .Result indicated that the lime stabilization at 7% is better than thecombination of 4% egg shell powder + 3% lime[1].

3.2 Okonkwo.U.N

Okonkwo.u.n et.al. had study and aimed at determing the effects of egg shell ash on strength properties ofcement stabilized lateritic soil. All proportions of cement andegg shell ashcontentswere measured in percentage byeweight of thedrysoil.The compaction test, california bearing ratio,unconfined compressive strength and durability test were carried out on the soil-cement egg shell ash mixture.The increase in eggshell ash content increased the optimum moisture content but reduce the max dry density of the soil cement eggshell ash mixtures.Also the increase in eggshell ash content considerably increased the strength properties of soil-cement egg shell ash mixture upto 35% in the average but fell short of the strength requirements expect the durability was satisfied[2].

4.0 Materials Used

4.1 Clay soil

The soil used in this study was collected from areaNeelambur, Coimbatore. The sample was thoroughly oven dried, weighed and stored in sacks at room temperature. The general property of the soil was thoroughly studied in the laboratory. The soil was tested for liquid limit, plastic limit optimum moisture content, maximum dry density, permeability etc.

Figure4.1 Clay soil

4.2. Egg Shell Powder (ESP)

Eggshell powder (ESP) has not being in use as a stabilizing material and it could be a good replacement for industrial lime, since it's chemicalcomposition is similar to that of lime. Chicken eggshell is a waste material from domestic sources such as fast food joints and homes. Literature has shown that eggshell powder primarily contains CaO (99.83%) and the remaining consists of Al2O3, SiO2, Cl, Cr2O3, MnO and CuO[3]. The eggshell waste was washed and dried before grinding.

Figure 4.2 Egg Shell Powder

4.3. Quarry Dust (QD)

Quarry dust/crusher dust is obtained as soil solid wastes during crushing of stones to obtain aggregates. Quarry dust exhibits high shear strength which is highly beneficial for its use as a geotechnical material. It has a good permeability and variation in water content does not seriously affect its. Desirable properties. Quarry dust proved to be a promising substitute for sand and can be used to improve the engineering properties of soils. The dry density increased with the addition of quarry dust with attendant decrease in the optimum moisture content. The Quarry Dust used was collected from a RMC (ARASUR)

Figure 4.3 Quarry Dust

5.0 Properties of Clay Soil

Table 5.1 Properties of clay soil

Sl.No.	Properties of the Clay soil	
1	Specific gravity	2.63
2	Liquid limit	18
3	Shrinkage limit	25.25
4	Plastic limit	22.22
5	Standard Procter compaction test	16.78kg/m^3
6	Unconfined Compressive strength	2.43x10^{-3}N/mm^2
7	Relative density	55.435%

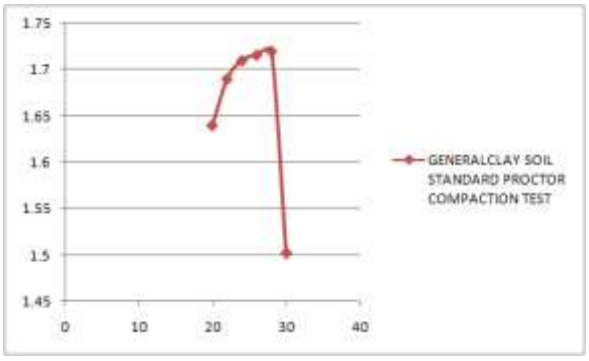

Figure 5.1 SCPT for Normal clay soil

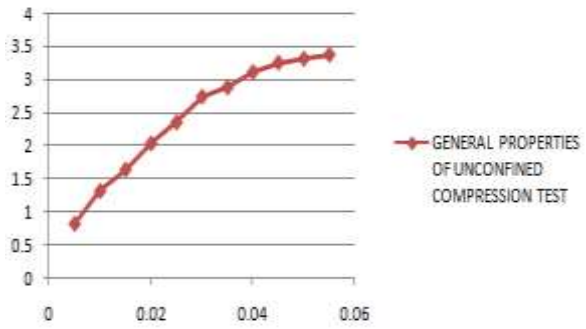

Figure 5.2 UCC for Normal clay soil

6.0 Experimental setup

The experimental program consisted of by varying the percentage of eggshell powder and quarry dust to the soil and studied the compaction characteristics and Unconfined compressive strength of soil. The quarry dust was varied between 10, 20,30and 40%and egg shell powder as constant 20% by weight of soil

6.1 Experiment details

Study on Soil Properties using varying percentages of Egg Shell Powder and quarry dust consisted of

- Proctor Compaction Test
- Atterberg Limits
- Unconfined Compressive strength
- California Bearing Ratio

7.0 Results and Discussions

From the experiments conducted with optimum percentage of ESP and varying percentage of Quarry Dust and the obtained results were shown below.

7.1 Compaction Characteristics

By addition of eggshell powder and quarry dust to the soil, the maximum dry density and optimum moisture content was found by Proctor compaction test as per IS 2720[4,5,6,7].

Table 7.1Influence of ESP and QD on optimum moisture content and max.dry density

EGG SHELL POWDER (%)	QUARRY DUST (%)	OMC (%)	MDD (g/cc)
20	10	26	1.651
20	20	28	1.716
20	30	30	1.722
20	40	26	1.693

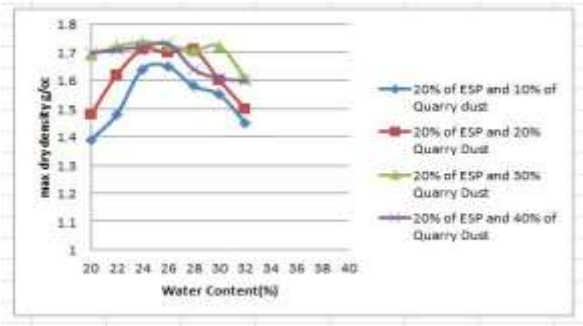

Figure 7.1 Comparative Graph for SCPT

7.2unconfined Compressive Strength

Table 7.2 Unconfined compressive strength

EGG SHELL POWDER (%)	QUARRY DUST(%)	STRESS N/mm^2
20	10	$8.4125x10^{-3}$
20	20	$13.7x10^{-3}$
20	30	$15.28x10^{-3}$
20	40	$8.085x10^{-3}$

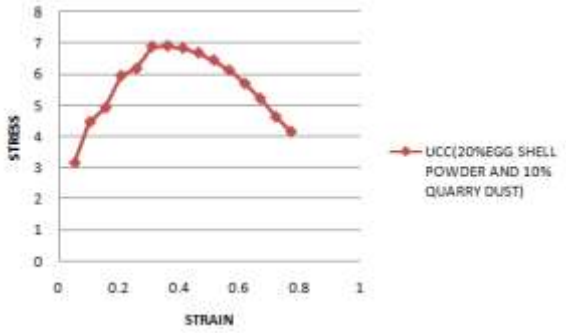

Figure 7.2 UCC for 20% ESP and 10% Quarry dust

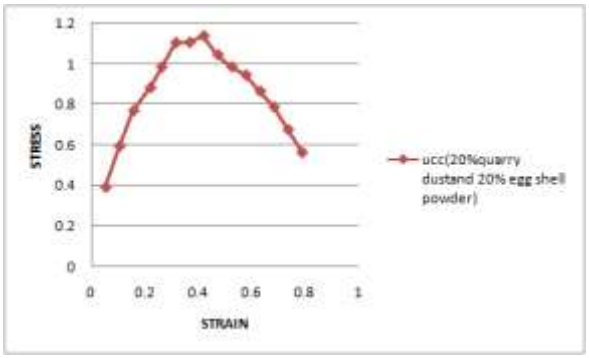

Figure 7.3UCC for 20% ESP and 20% Quarry dust

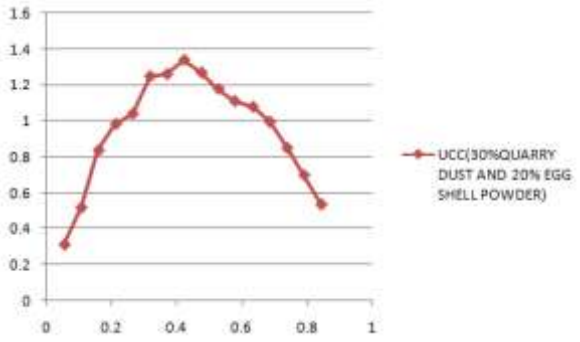

Figure 7.4 UCC for 20% ESP and 30% Quarry dust

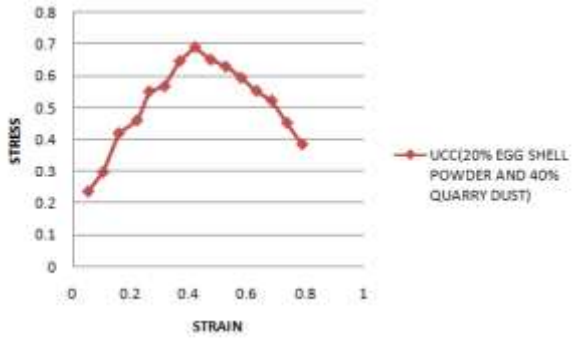

Figure 7.5 UCC for 20% ESP and 40% Quarry dust

7.3 California Bearing Ratio

Table 7.3 California Bearing Ratio

EGG SHELL POWDER (%)	QUARRY DUST(%)	CBR(%)
20	10	11.09
20	20	14.39
20	30	23.58
20	40	13.18

7.4 Atterberg's Limit:

7.4.1 Liquid Limit

Table 7.4 Liquid Limit

EGG SHELL POWDER (%)	QUARRY DUST(%)	LIQUID LIMIT(%)
20	10	28.4
20	20	26
20	30	24
20	40	28

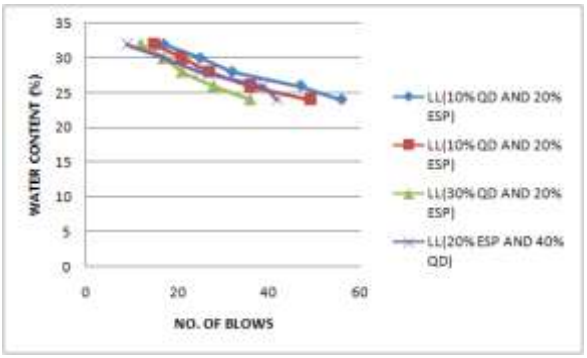

Figure 7.6 Liquid Limit for Atterberg's Limit

7.4.2 Plastic Limit

Table 7.5 Plastic limits

EGG SHELL POWDER (%)	QUARRY DUST(%)	PLASTIC LIMIT(%)
20	10	22.22
20	20	25
20	30	28.57
20	40	16.67

8.0 Conclusions

Egg shell powder and Quarry dust is added in the Clay Soil. Following conclusions were obtained based on the experimental investigations

- The Optimum Moisture content was found to be increased
- The California bearing ratio was found to be increased.
- The unconfined compressive strength will be increased.
- specific gravity of the clay was found to be 2.7
- Addition of various % of egg shell powder and quarry dust into the soil progressively decreases Optimum moisture and increases Maximum dry density.

9.0 References

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