Stabilization of Black Cotton Soil by Fly Ash and Egg Shell Powder

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Abstract - Optimum dosage of admixture was found to be 20%. Increment in specific gravity was found to 2.35 to 2.6 at this dosage. Increment in Cu was found to be from 5.71 to 7.77 & Cc was found to be 0.53 to 1.18 at this dosage.

Decrement in liquid limit was found to be from 65% to 58% at this dosage. Decrement in plastic limit was found to be from 35% to 32% and plasticity index was found to be from 30% to 26%. Increment in maximum dry density was found to be from 1.583g/c.c to 1.63g/c.c at this dosage. Increment in shear strength was found to be from 0.149kg/cm2 to 0.165kg/cm2 at this dosage. Increment in CBR value was found to be from 2.53% to 2.82%. The maximum dry density, shear strength and CBR value increases upto 20% dosage of admixture and beyond this there is a reduction in maximum dry density, shear strength and CBR value. Liquid limit, plastic limit and plasticity index values decreases upto 20% dosage of admixture and beyond this there is a reduction in liquid limit, plastic limit and plasticity limit.

I. INTRODUCTION

Black cotton soil (BCS) is basically known as expansive soil. It is reddish brown to black in colour which help in cultivation of cotton and hence it known as black cotton soil. It mainly occurs in arid and semiarid regions of the world. This soil is problematic to the engineering structures different damages may occur in disjoining of soil, difference in settling properties etc. which is observed in the bridges, sewerage lines etc.

For any land-based structure, the foundation is very important and has to be strong to support the entire structure. In order the foundation to be strong around it plays a critical role. So, to work with soil we need to have proper knowledge about their properties and factors which affect their behavior. The process of soil stabilization helps to achieve the required properties in a soil needed for construction work.

For the beginning of construction work the necessity of enhancing soil properties has come to light. Ancient civilizations of the Chinese, Romans incase utilized various methods to improve soil strength some of these methods were so effective that their buildings and roads still exist.

Stabilization is being used for a variety of engineering work, the most common application being in the construction of road and air field pavements, where the main objective is to increase the strength or stability of soil and to reduce the construction cost by making best use of locally available materials.

The process may include blending soil to achieve a desired gradation or mixing admixtures that may alter the gradation, change the strength and durability or act as a binder to soil.

In present study fly ash and egg shell powder were used to study the effects on properties on black cotton soil

Needs

Soil properties vary a great deal and construction of structures depends a lot on the bearing capacity of the soil, hence we need to stabilize the soil which makes it easier to predict the load bearing capacity of the soil and even improve the load bearing capacity.

The gradation of the soil is also a very important property to keep in mind while working with soils. The soils may be well graded which is desirable as it has a smaller number of voids or uniformly graded which though sounds stable but has more voids. Thus, it is better to mix different types of soils together to improve the soil strength properties.

Objectives

- To study the improvement on properties of black cotton soil with the addition of fly ash and egg shell powder at varying percentages.

- To propose an efficient mix proportion of stabilizer.
- To improve the engineering properties of black cotton soil and make it suitable for construction of subgrades
- Sometimes soil stabilization is also used to prevent soil erosion or formation of dust, which is very useful especially in dry and arid weather.
- To improves the workability and the durability of the soil.
- To reduce the soil volume change due to change in temperature or moisture content.

II. LITERATURE REVIEW

Erdal Cokca (2001): Effect of fly ash on expansive soil was studied by Erdal Cokca. Fly ash consists of often hollow spheres of silicon, aluminum and iron oxides and unoxidized carbon. There are two major classes of fly ash, Class C and class F. The fly ash can provide an array of divalent and trivalent cations under ionized conditions that can promote flocculation of dispersed clay particles. Thus expansive can be potentially stabilized effectively by cation exchange using fly ash. He carried out investigations using soma fly ash and added it to expansive soil at 0-25%. And his experimental findings confirmed that the plasticity index, activity and swelling potential of the sample decreased with increasing percent and curing time and optimum percent was found to be 20%.

AMU.O.O :Amu.o.o studied the effect of egg shell powder on the stabilizing potential of lime on an expansive soil. He conducted series of test to determine the optimal percentage of lime egg shell powder combination. The optimal quantity of lime was gradually replaced with suitable amount of egg shell powder result indicated that the lime stabilization at 7% is better than the combination of 4% egg shell powder + 3% of lime.

Okonkwo.U.N: Okonkwo.u.n had study and aimed at determining the effects of egg shell ash on strength properties of cement stabilized lateritic soil. All proportions of cement and egg shell ash contents were measured in percentage by weight of dry soil. The compaction test the California bearing test, unconfined compressive test and durability test were carried out on the soil cement egg shell ash mixture. The increase in egg shell ash content increased the optimum moisture content but reduce the maximum dry density of the soil cement egg shell 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 except the durability was satisfied.

Phanikumar and Sharma (2004): A similar study was carried out by Phanikumar and Sharma and the effect of fly ash on engineering properties of expansive soil through an experimental program. The effect on parameters like free swell index, swell potential, swelling pressure, plasticity, compaction, strength and hydraulic conductivity of expansive soil was studied. The ash blended expansive soil with fly ash content of 0, 5, 10, 15 and 20% on a dry weight basis and they inferred that increase in fly ash content reduces the plasticity characteristics and the FSI was reduced by about 50% by addition of 20% fly ash . The hydraulic conductivity of expansive soils mixed with fly ash decreases with an increase in fly ash content, due to the increase in maximum dry unit weight with an increase in fly ash content. When the fly ash content increases there is a decrease in the optimum moisture content and the maximum dry unit weight increases. The effect of fly ash is akin to the increased compactive effort. Hence the expansive soil is rendered more stable. The undrained shear strength of the expansive soil blended with fly ash increases with increase in the ash content.

Onyelowe ken C: According to Onyelowe Ken C et al revealed that the use of quarry dust in soil stabilization is to improve engineering properties of soil. Quarry dusts are considered as one of the well accepted as well as cost effective ground improvement for the stabilization of weak soil deposits. When quarry dust is added with expansive soil it is expected that it will make it more porous, less durable, reduce cohesion etc., and also quarry dust has rough, sharp and angular particles and as such causes a gain in strength due to better interlocking.

Charles M.O Nwaiwu: Charles M.O Nwaiwu and et al. studied the influence of quarry dust, black soil mixture on compactive effort which effects which influences

properties such as maximum dry unit weight, optimum moisture content , California bearing ratio test and swelling pressure . Maximum dry unit weight as well as *CBR* increased with quarry dust content while *OMC* decreased at higher quarry dust content. These effects were more pronounced at the heavy compaction which yielded the highest compactive effort. Free swell strain, swell potential and swelling pressure decreased as quarry dust content increased. However, the highest values of *Sf* and *Ps* were obtained at the *BS* heavy compaction effort for each percent of quarry dust added.

Nabil Al-Joulani: Nabil Al-Joulani studied the Effect of Stone Powder and Lime on Strength, Compaction and CBR Properties of Fine Soils, revealed that the addition of 30% stone powder has increased the angle of internal friction (φ) by about 50% and reduced cohesion by about 64%. The addition of 30% of lime has decreased the friction angle and cohesion by 57% and 28%, respectively. The maximum dry density and optimum moisture content decreased slightly by addition of 30% stone powder, however, the addition of 30% lime decreased the maximum dry density and optimum moisture content by 19% and 13.5%, respectively. The CBR values have increased from 5.2 to 16 and 18 by the addition of 30% stone powder and lime, respectively.

III. MATERIALS AND METHODOLIGIES

Materials used in the experimental study are black cotton soil, fly ash and egg shell powder

Methodology: -

The soil is collected from a field near Bhalki. The soil sample from the site was collected with hand tools, packed in plastic bags. The bags were then taken to geotechnical engineering laboratory. The soil sample was then oven dried, broken up, silted through 20mm sieve and placed in bags for geotechnical investigation.

The egg shell was collected from nearby hotels. The egg shell as per the requirement is finely powdered to size finer than 150 micron and retained on 75 micron IS sieve.

Fly ash is collected from thermal power plant Raichur.

After collecting the Black cotton soil, egg shell powder and fly ash. They are stabilized with black cotton soil with different proportions such as 90:3:7, 80:6:14 & 70:9:21

The test to be conducted to study the effect of egg shell powder and fly ash are Standard proctor test, direct shear test and California bearing ratio test.

TESTS ARE CONDUCTED WITH FOLLOWING PROPORTIONS

A. Pure black cotton soil.

B. Black cotton soil + 3% egg shell powder + 7% fly ash.

C. Black cotton soil + 6% egg shell powder + 14% fly ash.

D. Black cotton soil + 9% egg shell powder + 21% fly ash.

Tests conducted in experimental study

- SPECIFIC GRAVITY.
- PARTICLE SIZE DISTRIBUTION.
- LIQUID LIMIT.
- PLASTIC LIMIT.
- STANDARD PROCTOR TEST.
- DIRECT SHEAR TEST.
- CALIFORNIA BEARING RATIO TEST.

IV. RESULTS

1. Comparative results for specific gravity

Trial no.	Description	Result
1	Black cotton soil	2.35
2	Black cotton soil + 3% egg shell powder + 7% fly ash	2.48
3	Black cotton soil + 6% egg shell powder + 14% fly ash	2.60
4	Black cotton soil + 9% egg shell powder + 21% fly ash	2.52

The maximum specific gravity is 2.60.

2. Comparative results for grain size distribution

Trial no.	Description	Result
1	Black cotton soil	Cu=5.71, Cc=0.53
2	Black cotton soil +3% egg shell powder+7% fly ash	Cu=6.50, Cc=0.72
3	Black cotton soil + 6% egg shell powder +14% fly ash	Cu=7.77, Cc=1.18
4	Black cotton soil + 9% egg shell powder +21% fly ash	Cu=7.57, Cc=1.04

The maximum Cu = 7.77 & Cc = 1.18.

3. Comparative results for liquid limit

Trial no.	Description	Result
1	Black cotton soil	LL = 65%
2	Black cotton soil +3% egg shell powder+7% fly ash	LL = 68%
3	Black cotton soil + 6% egg shell powder +14% fly ash	LL = 58%
4	Black cotton soil + 9% egg shell powder +21% fly ash	LL = 64%

The Lowest liquid limit is 58%.

4. Comparative results for plastic limit

Trial no.	Description	Result
1	Black cotton soil	PL = 35%, Plasticity index = 30%
2	Black cotton soil + 3% egg shell powder +7% fly ash	PL = 34%, Plasticity index = 28%
3	Black cotton soil + 6% egg shell powder +14% fly ash	PL = 32%, Plasticity index = 26%
4	Black cotton soil + 9% egg shell powder +21% fly ash	PL = 34%, Plasticity index = 30%

The lowest plastic limit is 32% & plasticity index is 26%.

5. Comparative results for standard proctor test

Trial no.	Description	Result
1	Black cotton soil	Max. dry density =1.583g/c.c Avg. moisture content =28%
2	Black cotton soil +3% egg shell powder+7% fly ash	Max. dry density =1.63g/c.c Avg. moisture content = 25%
3	Black cotton soil + 6% egg shell powder +14% fly ash	Max. dry density = 1.66g/c.c Avg. moisture content = 22%
4	Black cotton soil + 9% egg shell powder +21% fly ash	Max. dry density = 1.63g/c.c Avg. moisture content = 26%

The maximum dry density is 1.66g/cc and average moisture content is 22%

6. Comparative results for direct shear test

Trial no.	Description	Result
1	Black cotton soil	Angle of internal friction= 40° Cohesion intercept C=0.04kg/cm^2 Shear strength q=.149kg/cm^2
2	Black cotton soil +3% egg shell powder+7% fly ash	Angle of internal friction= 41.5° Cohesion intercept C=0.06kg/cm^2 Shear strength q=.157kg/cm^2
3	Black cotton soil + 6% egg shell powder +14% fly ash	Angle of internal friction= 43° Cohesion intercept C=0.07kg/cm2 Shear strength q=0.165kg/cm^2
4	Black cotton soil + 9% egg shell powder +21% fly ash	Angle of internal friction= 42° Cohesion intercept C=0.06kg/cm2 Shear strength q=.163kg/cm^2

The maximum shear stress is 0.165kg.cm^2 with cohesion intercept 0.07kg/cm^2 and angle of internal friction as 43°

7. Comparative results for CBR test

Trial no.	Description	Result
1	Black cotton soil	CBR value = 2.53%
2	Black cotton soil +3% egg shell powder+7% fly ash	CBR value = 2.62%
3	Black cotton soil + 6% egg shell powder +14% fly ash	CBR value = 2.82%
4	Black cotton soil + 9% egg shell powder +21% fly ash	CBR value = 2.68%

The maximum CBR Value is 2.82%

V. DISCUSSION

On the basis of present experimental study the following conclusions are drawn

1. Optimum dosage of admixture was found to be 20%.
2. Increment in specific gravity was found to 2.35 to 2.6 at this dosage.
3. Increment in Cu was found to be from 5.71 to 7.77 & Cc was found to be 0.53 to 1.18 at this dosage.
4. Decrement in liquid limit was found to be from 65% to 58% at this dosage.
5. Decrement in plastic limit was found to be from 35% to 32% and plasticity index was found to be from 30% to 26%.
6. Increment in maximum dry density was found to be from 1.583g/c.c to 1.63g/c.c at this dosage.
7. Increment in shear strength was found to be from 0.149kg/cm2 to 0.165kg/cm2 at this dosage.
8. Increment in CBR value was found to be from 2.53% to 2.82%.
9. The maximum dry density, shear strength and CBR value increases upto 20% dosage of admixture and beyond this there is a reduction in maximum dry density, shear strength and CBR value.
10. Liquid limit, plastic limit and plasticity index values decreases upto 20% dosage of admixture and beyond this there is a reduction in liquid limit, plastic limit and plasticity limit.

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