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Research Paper

ANALYZING THE EFFECTIVENESS OF DIFFERENT ADDITIVE COMBINATIONS ON SOIL STRENGTH PARAMETERS

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***Abstract*— Soil improvement is considered an alternative when the naturally available soil does not meet the required engineering properties for construction. A deep foundation is typically used in weak soil, but shallow foundations can be adopted using ground improvement techniques This study examines the locally available soil in the Bheemili district. Initially we determined Index properties of the soil followed by California Bearing Ratio. California bearing ratio for Coffee Husk with Fly Ash and Coffee Husk with Copper Slag of different percentages (5%,10%,15% of coffee husk, and 5% of either fly ash or copper slag). Based on our investigation, we found that 5% coffee husk with fly ash and 5% coffee husk with copper slag gave the highest strength. In the comparison of the two combinations, coffee husk of 5% with copper slag of 5% gave appreciable results.**

***Index Terms*— Soil improvement, copper slag, coffee husk, California bearing ratio,**

I. INTRODUCTION

1.1 General

Our earth is covered by about 70% of water and only 30% of land. The earth's crust is composed of soil and rock. Rocks are often considered a consolidated material but the soil is defined as unconsolidated sediment and deposits of solid particles that have resulted from the disintegration of rock. Soils can be grouped into two categories depending on the method of deposition Residual soils have formed from the weathering of rocks and remain at the location of their origin. Residual soils can include particles having a wide range of sizes, shapes, and compositions depending on the amount and type of weathering and the minerals of the parent rock. Transported soils are those materials that have been moved from their place of origin and settled in other places Transportation may have resulted from the effect of gravity wind, water glaciers. or human activities. The method of transportation and deposition has a significant effect on the properties of the resulting soil mass. Many large land areas have been formed with transported soils which are deponed primarily by one of the transportation methods. The origin and transportation will sometimes strengthen the soil and weakens soil. Therefore, the engineer should consider the soil beneath for the construction of any structure on it. Soil is the topmost layer of the Earth's surface and in composed of an unconsolidated earth material that is prone to erosion. Besides its natural conditions, soil erosion is triggered by anthropogenic activities

Soil is a renewable natural resource, which covers a large portion of the earth's surface. It is an important natural resource that directly or indirectly supports most of the planet's life. It is a mixture of both mineral and organic constituents that are in solid, gaseous, and aqueous forms. The fabric of soil particles packs loosely, forming a soil structure within, filled with pore spaces and these pores contain liquid and air.

1.2 Problematic soils:

Natural soils, usually lack the mechanical and geotechnical properties required for construction projects and, require treatment to achieve geotechnical acceptable conditions Clay soils present many difficulties for geotechnical and civil engineers due to their weak strength, high sensitivity to moisture, and excessive swelling

Problematic soils are those that make the construction of a foundation extremely difficult. They include expansive soils, collapsing soils, and sanitary landfill. Their distribution can vary widely, both aerially and in-depth. These soils exhibit certain properties which are undesirable to any foundation. Expansive and collapsing soils cause high differential property or settlement in structures. Similar problems also arise in the foundations of sanitary landfill. Such soils must be identified prior in the field before construction is planned. Although not all the problems caused by problematic soils can be solved. Preventive measures can be taken to reduce the extent of damage done to structures built on them.

II. OBJECTIVES

The present study of this project is aimed at, analysing the influence of coffee husk with Fly ash and coffee husk with copper slag on the soil engineering properties. To attain following objectives.

- In order to determine the soil engineering properties.
- To analyze the performance of the soil with different additives (coffee husk with fly ash and coffee husk with copper slag) respectively and the compaction characteristics, unconfined compressive strength (UCS) and California Bearing Ratio (CBR) for the various proportions like 5%,10%, and 15%
- To find the optimum percentage of fibres of coffee husk with fly ash and coffee husk with copper slag by analysing the index and engineering properties

III. LITERATURE STUDY

3.1 Strength and compressibility behaviours of expansive soil treated with coffee husk ash

M.K. Atahu, F.Saathoff, A. Gebissa

ABSTRACT:

Roads built on expansive soil are susceptible to early damage due to the swelling and shrinkage characteristics of this kind of soil under changing moisture conditions.

The most common technique used to improve the properties of problematic soil is stabilization with additives. This study deals with the treatment of expansive soil with coffee husk ash (CHA).In this study, the bearing capacity and compressibility characteristics of expansive soil is stabilized with varying percentages of CHA 5%, 10%, 15%.

Tests conducted in this experiment are California Bearing Test and Compressibility Test. BC soil samples used in this study were collected from Ambo Area, where the soil is located in the West Shewa Zone of the Oromia Regional State, Ethiopia.

RESULTS:

The soaked CBR value of untreated BC soil is 1%. After treated with 20% CHA, the value increased by three-fold and was 3.1%. For the unsoaked CBR test, addition of 20% CHA increases the bearing capacity from 8.3% to 10.67%.

The percentage increment of CBR value for unsoaked condition is 28%, while it increases by 203% for soaked condition. The results indicate that CHA improves the bearing capacity of the investigated soil.

The study also reveals that for the maximum concentration of CHA (20%), the swell percentage decreases from 10% to 5.7%, indicating a significant decrement of about 43%.

3.2 Coffee Husk Ash and Cement as Special Ingredients: Stability Analysis on Black Cotton Soil

Subash Thanappan , Riyaz Khan N.H

ABSTRACT:

For improving the engineering properties of such an expansive soil and to make it more stable, soil stabilization using the suitable ingredients is of prime importance. It was done by the use of heavy compaction, proportioning and addition of different type of admixtures and stabilizers

Materials used in this experiment are Black cotton soil , Coffee husk ash and Cement.

Keeping the cement percentage as the constant (2%), only the CHA was added to the original soil samples in different proportions such as 4%, 8% and 15%.

Tests conducted are Free swell ,Plastic limit and Liquid limit

RESULTS:

The free swell index of the soil samples under the investigation (Figure 3) are found to be 87.5%, 72.7% and 75% respectively. According to Brajesh Mishra (2015), the free swell index of black cotton soil varies between 40% and 180%.

he plastic limit of the above three soil samples is 28.92%, 37.9% and 36.02% respectively. Brajesh Mishra (2015) says the plastic limit of black cotton soil ranges from 20% to 60%.

The liquid limit of soil sample 1 is observed as 73%. According to Brajesh Mishra (2015), the liquid limit of black cotton soil ranges between 40-120%.

The specific gravity of the soil samples was determined using the density bottle of 200cc shows that the range varies between 2.56 and 2.66. Hence the type of soil samples was found to be BCS.

IV. METHODOLGY OF THE PROJECT

4.1 General:

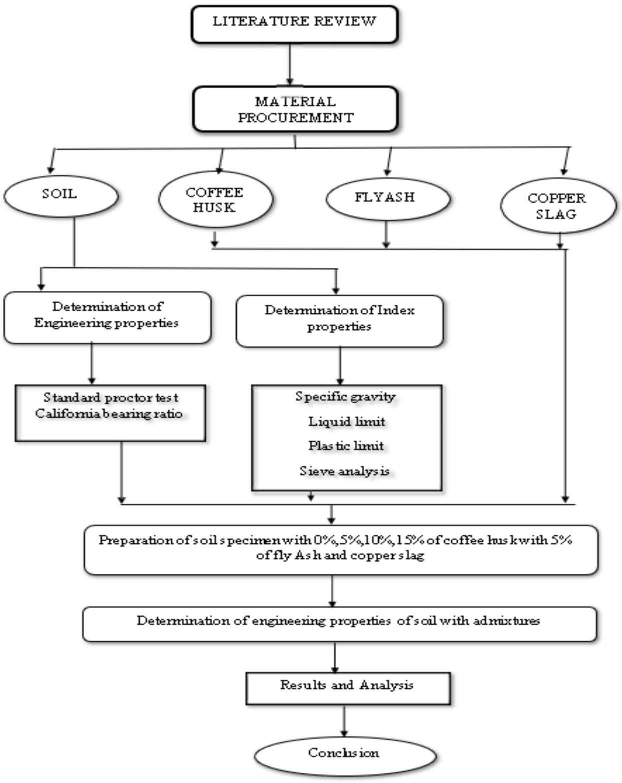
The soil investigation site is situated at 17.887 latitude and 83.4456 longitude in Bheemili, Andhra Pradesh, India. The GPS coordinates of the location are 17°53'15.06" N and 83°26'44.44" E.

The area under investigation covers approximately 238 square kilometres, with half falling under the jurisdiction of the Greater Visakhapatnam Municipal Corporation and the remaining area belonging to the Bheemili Municipality. Bheemili is a town, and the Mandal headquarters are located in the Visakhapatnam district of Andhra Pradesh. The study proposes the expansion of the four-lane roads between Bheemili and Bhogapuram to enhance access to the airport and connect to Bheemili.

The road that runs parallel to the Bay of Bengal's coastline is vulnerable to the natural activities on both sides of the island, making it susceptible to the natural vagaries of the sea coast. Given the traffic load, recent road expansions have been undertaken in place of the old road network. Hence, this is taken up to investigate. However, there are several methods to stabilize soil, soil strengthening with agricultural waste materials is the most eco-friendly and economically affordable method.

Figure 4.1 Geographical map of Bheemili

4.2 Workplan



V. RESULTS

Geotechnical properties of soil sample:

- To study the geo-technical characterization of soil in this region. The soil samples were collected at a depth of 1.0-1.5m from the ground level and collected sample were dried and subjected for geotechnical characteristics.

The geotechnical characteristics such as liquid limit, plastic limit, plastic index, IS classification of soil, compaction and CBR as per **IS 2720** were conducted

Characteristics	Results
Liquid Limit	39%
Plastic Limit	13%
Plasticity Index	26
Water content	9.31
Type of soil	Intermediate Clay (CI)
OMC	14%
MDD	1.59 g/cc
CBR	2.965

Table 5-1 Index results of the soil

5.1 Additive combinations

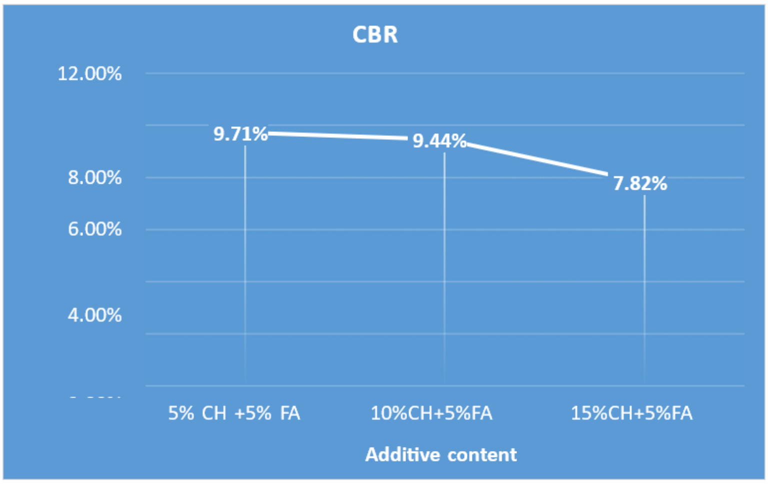
We have tried combinations of additives of varying percentages (i.e., 5%,10%15%) of coffee husk while maintaining the fly -Ash and Copper Slag percentage constant (i.e., 5%) respectively.

Soil contents is replaced with the respective percentages of weights of dry soil. The above OMC (14%) is used for conducted the CBR test. And the below table represents the CBR values of different combinations.

5.2 Coffee husk with Fly ash

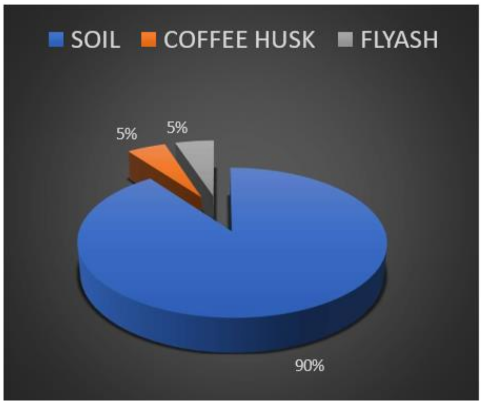
FLYASH	COFFEE HUSK	CBR VALUE
5%	5%	9.705
5%	10%	9.435
5%	15%	7.82

Table 5-2 CBR values for CH & FA



Graph 5-1 Showing CBR values of soil with CH & FA

In the above combinations it was found that combination of 5%of fly ash with 5% of coffee husk have given a significant strength.

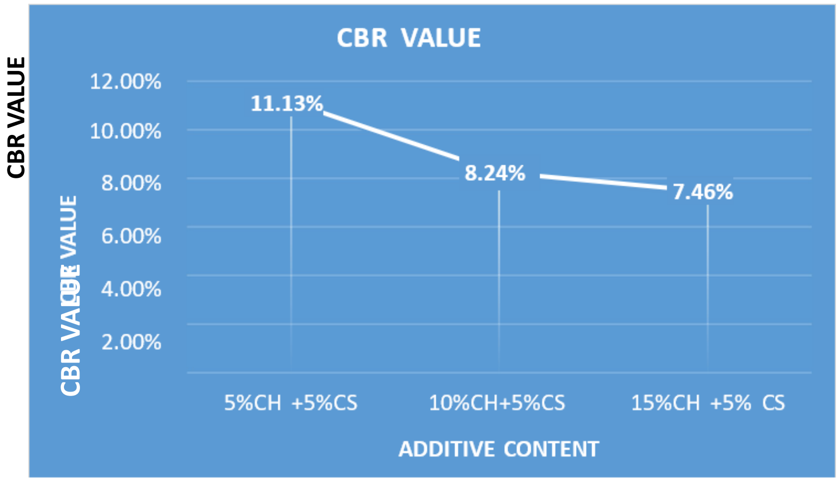


Coffee husk and Copper slag

The further combination with copper slag is given below

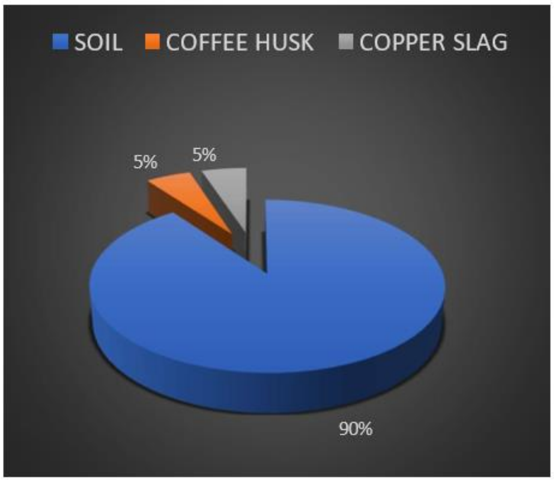
Copper Slag	COFFEE HUSK	CBR VALUE
5%	5%	11.13
5%	10%	8.24
5%	15%	7.46

Table 5-3 CBR values for CH & CS



Graph 5-2 Showing CBR values of soil with CH &CS

In the above combinations it was found that combination of 5%of copper slag with 5% of coffee husk have given a significant strength.

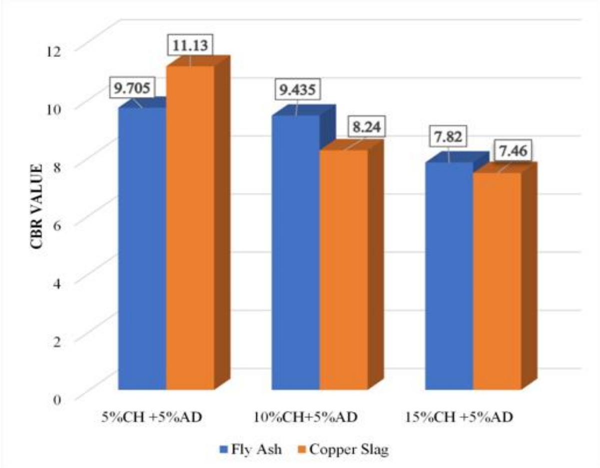


VI. COMPARITIVE ANALYSIS

From the combinations it was found that copper slag has given a significant strength.

- For the same percentages of the admixtures, Copper Slag have given a significant strength.

CH :: Coffee husk AD :: Additives



Graph 6-1 Comparison of Flash and Copper Slag

VII. CONCLUSION

- Our analysis indicates that the in-situ soil has an initial CBR of 2.695 which indicates poor strength for subgrade.

5% Coffee husk + 5% Fly ash (9.71)

5% Coffee husk + 5% Copper slag (11.13)

- According to the current experiments, the above combination of additives has given the better results.
- The above combinations, initially worked well, but with the increasing Coffee Husk content the results were **declining.**
- In this comparison ***Coffee Husk with copper slag is more Effective,*** than Coffee Husk with Fly ash.

Scope:

- Further properties (shear parameters) of the soil shall be determined and investigation can be conducted using the same additives as **layers** in the soil mass for better results.

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