AN EXPERIMENTAL STUDY ON SOIL STABILIZATION BY USING FLY ASH

G. Vigneswari[1], M.Ranjitha[2], G.Sangeetha[3], J.Ramya[4]
[1]Assistant Professor, Department of Civil Engineering, Anna University.
Final year, Department of civil engineering, Anna University
Sethu Institute of Technology, pulloor – 626 115, kariappati, virudhunagar, India

Abstract
This paper explains about a stabilization of red soil using fly ash. To evaluate the effects of waste fly ash on shear strength of soil by carrying out an unconfined compression test and California bearing ratio test on different soil samples. To obtain index properties and engineering properties of those soil samples test like liquid limit, plastic limit, standard proctor test, unconfined compressive strength, California bearing ratio, direct shear test were conducted. The ratio of the mix will be on adding fly ash as (0%, 3%, 6%,9%).

***Keywords* – fly ash, California bearing ratio(CBR), direct shear, unconfined compressive strength(UCC).**

I. INTRODUCTION

The term "Soil" has various meanings, depending upon the general professional field in which it is being considered. To an engineer, soil is the unaggregated or uncemented deposit of mineral or organic particles or fragments covering large portion of the earth's crust.

Many structures were built during the medieval period (about 400 to 1400 A.D). One of the main problems they had was about the compression of soil and the consequent settlement of building. Hence nowadays before starting the construction works, site investigation is equally necessary for analyzing the safety or causes of failure of existing works, for selecting construction materials and for deciding upon the construction methods to be applied. In general, the purpose of a site investigation is to obtain necessary information about the soil and hydrological conditions at the site and to know the engineering properties of the soil which will be affected. Hence in order to avoid these unexpected problems in the soil, reinforcing the soil is the best way to strengthen the soil and to avoid settlement of the soil.

Soil is a peculiar material. Some waste materials such as Fly Ash, rice husk ash, pond ash may use to make the soil to be stable. Addition of such material will increase the physical as well as chemical strength, liquidity index, plasticity index, unconfined compressive strength and bearing capacity etc. The objective of this study was to evaluate the effect of Fly Ash derived from combustion of sub-bituminous coal at electric power plants I stabilization of fine-grained red soils. California bearing ratio (CBR) and other strength property tests were conducted on soil. Aim of this research is to stabilize the locally available red soil around Madurai districts (chinnaodappu).

Fly ash is a byproduct from burning pulverized coal in electric power generating plants. During combustion, mineral impurities in the coal (clay, feldspar, quartz, and shale) fuse in suspension and float out of the combustion chamber with the exhaust gases. As the fused material rises, it cools and solidifies into spherical glassy particles called fly ash. Fly ash is collected from the exhaust gases by electrostatic precipitators or bag filters. The fine powder does resemble portland cement but it is chemically different. Fly ash chemically reacts with the byproduct calcium hydroxide released by the chemical reaction between cement and water to form additional cementitious products that improve many desirable properties of concrete. All fly ashes exhibit cementitious properties to varying degrees depending on the chemical and physical properties of both the fly ash and cement. Compared to cement and water, the chemical reaction between fly ash and calcium hydroxide typically is slower resulting in delayed hardening of the concrete. Delayed concrete hardening coupled with the variability of fly ash properties can create significant challenges for the concrete producer and finisher when placing steel-troweled floors.

II. MATERIAL USED

A. RED SOIL

Red soil is a naturally occurring granular material composed of finely divided rock and mineral particles. It is defined by size, being finer than gravel and coarser than silt .Red soils denote the third largest soil group of India covering an area of about 3.5 lakhs sq. km (10.6% of India's area) over the Peninsula from Tamil Nadu in the south to Bundelkhand in the north and Rajmahal hills in the east to Katchch in the west. They surround the red soils on their south, east and north. [3] It looks yellow in it's hydrated form. This soil in India, also known as the omnibus group, have been developed over granite, and other crystalline rocks, the sedimentaries of the Cuddapah and Vindhayan basins and mixed Dharwarian group of rocks. Their colour is mainly due to occurring as thin coatings on the soil particles while the occurs as or as, the color is red and when it occurs in the hydrate form as limonite the soil gets a yellow colour. Ordinarily the surface soils are red while the horizon below gets yellowish colour

B. FLY ASH

Fly ash is a byproduct from burning pulverized coal in electric power generating plants. During combustion, mineral impurities in the coal (clay, feldspar, quartz, and shale) fuse in suspension and float out of the combustion chamber with the exhaust gases. As the fused material rises,

it cools and solidifies into spherical glassy particles called fly ash. Fly ash is collected from the exhaust gases by electrostatic precipitators or bag filters. The fine powder does resemble portland cement but it is chemically different. Fly ash chemically reacts with the byproduct calcium hydroxide released by the chemical reaction between cement and water to form additional cementitious products that improve many desirable properties of concrete. All fly ashes exhibit cementitious properties to varying degrees depending on the chemical and physical properties of both the fly ash and cement. Compared to cement and water, the chemical reaction between fly ash and calcium hydroxide typically is slower resulting in delayed hardening of the concrete. Delayed concrete hardening coupled with the variability of fly ash properties can create significant challenges for the concrete producer and finisher when placing steel-troweled floors.

C. WATER

Water that is clean and free from injurious amounts of oils, acids, alkalis, salt, sugar, organic materials or other substances that may be deleterious to concrete is used.

III. Laboratory studies

The Various tests conducted on the clayey soil samples included determination of the physical and chemical properties of soils at their natural state. On the other hand, the testing was conducted on the red soil samples mixed with different percentages of fly ash included the standard proctor, unconfined compressive strength, direct shear and California bearing ratio.

A. Standard proctor compaction test

Standard proctor is the test used to determine the compaction of different types of soil and the properties of soil with a change in moisture content. And this is also used to determine the optimum moisture content (OMC) and maximum dry density (MDD).

B. California bearing ratio

The CBR is a penetration test for evaluation of the mechanical strength of natural ground, subgrades and base courses beneath new carriage construction. The CBR can also be used for measuring the load-bearing capacity of unimproved airstrips or of soils under paved airstrips. The harder the surface, the higher the CBR rating. The test is performed in CBR apparatus by measuring the pressure required to penetrate a soil sample at 2.5mm & 5mm with a plunger. The measured pressure in the dial guage is then divided by the pressure required to achieve an equal penetration on a standard sample.

C. Unconfined compressive strength

The purpose of this laboratory test is to determine the unconfined compressive strength of a soil sample. We will measure this with the unconfined compression test, which is an unconsolidated undrained test where the lateral confining pressure is equal to zero. UCS test is performed in accordance with the IS Standards in (1973). The sample sizes will be of 38 mm diameter and 76 mm length. At the optimum moisture content (OMC) and maximum dry density (MDD) the tests were performed.

D. Direct shear test

The test is performed on three or four specimens from a relatively undistrubed soil sample. A specimen is placed in a shear box which has two stacked rings to old the sample, the contact between the two rings is at approximately the mid-height of the sample. A confining stress is applied vertically to the specimen, and the upper ring is pulled laterally until the sample fails, or through a specified strain. The load applied and the strain induced is recorded intervals to determine a stress-strain curve for each confining stress. Several specimens are tested at varying confining stresses to determine the shear strength parameters, the soil cohesion (c) and the angle of internal friction, commonly known as friction angle. (φ

IV. RESULTS AND DISCUSSION

A. Standard proctor test (SPT)

The SPT test is conducted in the laboratory on soil sample with addition of fly ash in the different proportions. The table 1 which explains the optimum moisture content (OMC) and maximum dry density (MDD) of the different soil samples.

Table 1

SPT test result on soil samples.

Percentage	OMC	MDD
0%	8%	1.83
3%	12%	1.93
6%	10%	1.85
9%	12%	1.81

Figure 1 shows the graph for the SPT test which is conducted for the different proportions of the soil samples the value of 0%,3%,6%,9% fly ash which is treated with the red soil.

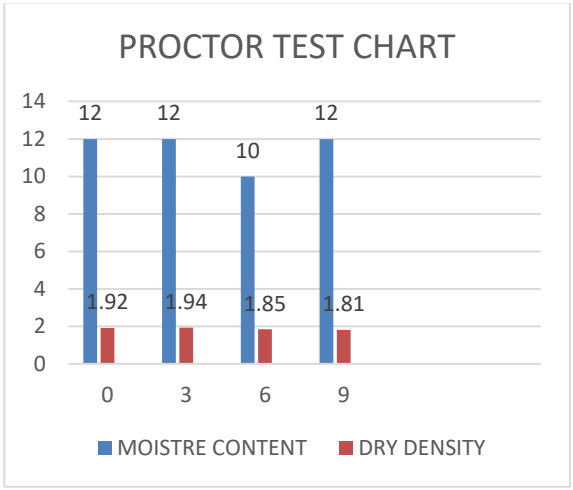

Figure 1 SPT test results for soil samples

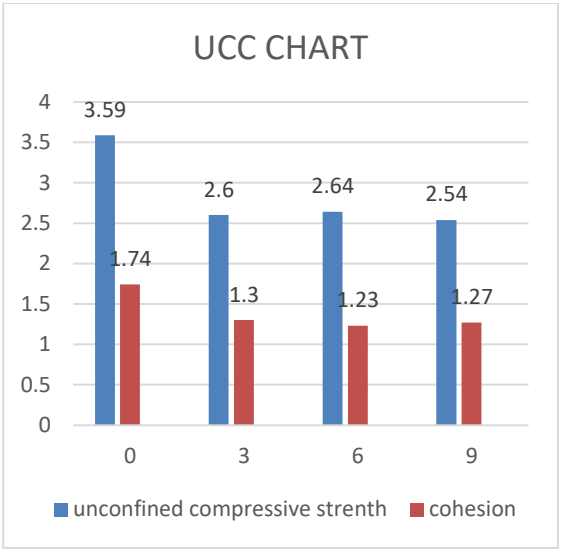

Figure 2 UCC test results for soil samples

B. Unconfined compressive strength

The purpose of this laboratory is to determine the unconfined compressive strength of a soil sample and the cohesion of the soil. By using the table 2, and the figure 2 shows the graph for UCC as given below.

TABLE 2

UCC test results on soil samples

Percentage	Compressive strength kg/cm²	Cohesion
0%	3.59	1.74
3%	2.60	1.3
6%	2.46	1.23
9%	2.54	1.27

Figure 2 shows the graph for the UCC test which is conducted for the different proportions of the soil samples the value of 0%,3%,6%,9% of fly ash which is treated with the red soil samples.

C. California bearing ratio

CBR test was conducted in laboratory on soil sample with addition of different percentages of fly ash and the results are obtained in the table 3.

Table 3

CBR test results for soil samples

Percentage	CBR ratio(%) for 2.5mm penetration	CBR ratio(%) for 5mm penetration
0%	14.84	14.68
3%	17.04	16.08
6%	17.24	16.72
9%	18.38	18.13

Figure 3 shows the graph for the value of CBR ratio which is conducted for different proportions of soil samples the value of 0%, 3%,6% and 9% fly ash which is mixed and treated with the red soil sample.

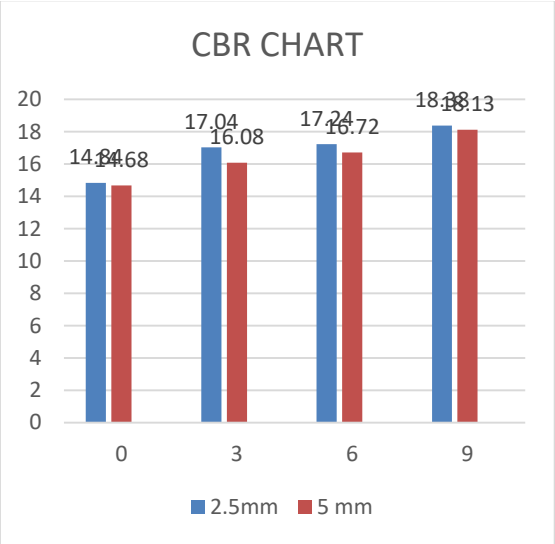

Figure 3 CBR test results for soil sample

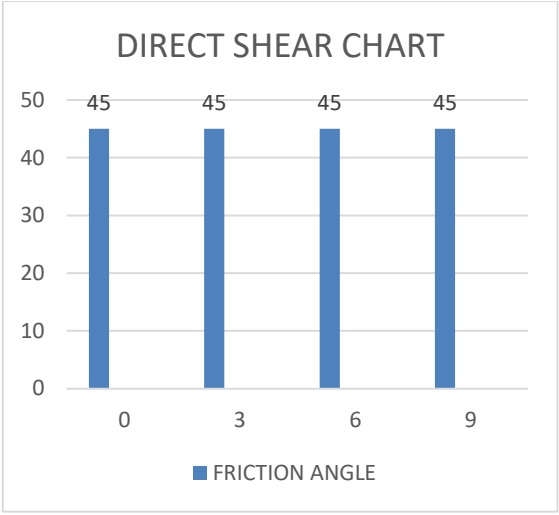

Figure 4 direct shear test results for soil sample

D. Direct shear test

Direct shear test was conducted in laboratory on soil sample with addition of different percentage of fly ash and the results are obtained table 4.

Table 4

Direct shear test result for soil samples

Percentage	Friction angle(φ) °
0%	45
3%	45
6%	45
9%	45

Figure 4 shows the graphs for the value of direct shear which is conducted for different proportions of red soil samples the value of 0%, 3%, 6% and 9% fly ash which is mixed and treated with the red soil sample.

V. CONCLUSION

Based on the experimental investigations carried out the following conclusions are arrived at:

- According to the results obtained in the sieve analysis, we got the sample as sand from selected material. Therefore we carried out tests for sand namely California Bearing Ratio and Direct Shear, Unconfined Compressive Strength.
- In the Standard Proctor Test at the 3% of addition of fly ash, the strength is effective.
- At the Unconfined Compressive Strength the percentage of strength decreases by 27.5%
- In the California Bearing Ratio the strength increases with all % of fly ash. Hence it is used for road side pavement.
- In the Direct Shear test all the friction angles (φ) are same. Hence it is used for foundation.

While the plysoil is reinforced with the non-woven geotextiles the value goes on increasing.

Hence this type of reinforcement to the soil helps to improve the strength and reduce the erosion due to the reinforcement of non-woven geotextiles. Mostly this is used in hilly areas and in precast concrete works.

REFERENCE

1. Karthic s, ashok kumar, gowtham, ilango. G, Gokul,thangaraj "Soil stabilization by using fly ash" IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684,p-

ISSN: 2320-334X, Volume 10, Issue 6 (Jan. 2014), PP 20-26 www.iosrjournals.org

2. S.M Mahajan , Dr.D.K Parbat“ Effect of fly ash on engineering properties on BC soil” Deepam publication’s ISSN 2395 – 6453 (Online) International Journal of Research in Engineering Science and Technologies (IJREST s) Civil Engineering August 2015, volume 1.
3. U. K. Maheshwari and N.K Saxena “Improving strength of soil by fiber and fly ash” International Research Journal of Engineering and Technology.(IRJET) e-ISSN: 2395 -0056 Volume: 03 Issue: 10 | Oct -2016 www.irjet.net.ISSN: 2395-0072
4. Varun buwa “Use of Flyash and Lime for Stabilization of Soft Soil”
EJGE Vol. 21 [2016], Bund. 18” International journal of geosynthesis and ground eng (2016)2:17 30 May 2016.
5. IS :2720 part-4 (1975): Grain size analysis
6. IS: 2720 part -6 (1972): Determination of Dry density and optimum moisture content.
7. IS: 2720 part-16 (1979): Determination of California bearing ratio.
8. Soil Mechanics by B.C PUNMIYA.
9. SoilMechanics and foundation engineering by R.K AARORA