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Stabilization of Expansive Soils Using Flyash

Paidi Sridevi[1], Ch. Kushalini[2], M. Santosh Kumar[3], M. Sandhya[4], V. Sampath Kumar[5], P. Sai Kiran[6]
[1]Assistant Professor, [2, 3, 4, 5, 6]UG Students, Department of Civil Engineering, Dr Lankapalli Bullaya College of Engg. for Women, Visakhapatnam, AP

Abstract: Soil plays an essential role in the construction of any civil engineering structure. It must be able to withstand the loads without breaking down. In some areas, the soil may not be strong enough to withstand the incoming loads. To address this, there are many methods of soil stabilization available, but some of these methods, such as chemical stabilization, lime stabilization, etc., can have an adverse effect on the soil's chemical composition. In this paper, we will be looking at the effects of fly ash on the strength gain of an expansive clay soil when combined with different percentages of fly ash, such as 0%, 5%, 10%, 15%, 20%, and 25%. We will also be looking at tests to determine the strength gain of the soil with and without fly ash. The results of the laboratory study will show that adding fly ash to the expansive clay soil reduces the soil's plasticity index and increases its MDD. The expansive clayey soil's strength characteristics have improved.

I. INTRODUCTION

The biological, chemical, or mechanical alteration of soil engineering properties is known as soil stabilisation. Soil stabilisation is a method used in civil engineering to enhance and improve the soil's engineering qualities. Mechanical strength, permeability, compressibility, durability, and plasticity are some of these attributes. While adding mechanical or physical improvements is popular, other schools of thought prefer to refer to chemical changes in the soil qualities by adding chemical admixtures as "stabilisation."

Construction of airfields, parking lots, landfills, embankments, roads and foundations, river management, agriculture, and mining sites all frequently include the stabilisation of soils. Depending on the situation, either one or a mixture of the two stabilisation techniques may be employed.

Pollution of the environment is a major issue facing the globe today. Many nations use thermal power plants to supply increasing cities with the energy they require. When this energy is being created, a large amount of fly ash is produced. Since these waste products are usually less expensive and safeguard the environment, using them in construction offers substantial advantages over present admixtures. Fly ash increases strength, decreases plasticity, and improves soil compaction. Unconfined compression tests, the California bearing ratio test, the compaction test, and the permeability test were performed to evaluate the strength of the mixtures. The tests were conducted in accordance with Indian Standard guidelines.

II. LITERATURE STUDIES

Mirsa (1998) stabilised the clay with class C fly ash. The compaction and strength behaviour of soils stabilised with Class C fly ash, as well as the physical and chemical properties of fly ash, were examined. Samples were made by mixing kaolinite and bentonite in tiny amounts. Moreover, fly ash exhibited the property of fast hydration. Higher densities and strengths were thus attained when compaction was done quickly or at all. Low densities and strength are the result of delayed compaction, though. It was shown that the plasticity and mineral type of the soil are connected to the stabilisation qualities. According to the results of the laboratory test, the usage of Class C fly ash for soil stabilisation depends on the amount of ash

Phani Kumar and Sharma (2004) demonstrate the efficacy of fly ash in fostering the engineering characteristics of expansive soils. Experiments have demonstrated the impact of fly ash on hydraulic conductivity, compaction, shear strength, plasticity index, swell index, and swelling pressure. The findings showed that when the fly ash content increased, the mix's plasticity index, hydraulic conductivity, and swelling characteristics decreased while its dry unit weight and shear strength increased. For a given water content, the resistance of the mixtures to penetrating rose dramatically as the fly ash percentage increased.

III. MATERIALS

Expansive soil: The study's expansive soil, which is locally accessible, was extracted two metres below the surface. The IS code 2720 (1974) is used to determine the expansive soil's index and engineering features.

Fly Ash: Fly ash of class C was applied. Its components are listed in the table: 1

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Table 1: Properties of Expansive soil

Properties	Values
Liquid limit (%)	51
Plastic limit (%)	31.46
Plasticity index (%)	19.54
Maximum Dry Density (g/cc)	16.2
Optimum Moisture Content (%)	36
Unconfined Compressive strength (kN/m2)	46.107
Permeability(cm/s)	6.715x10^-6

IV. EXPERIMENTAL TESTING PROCEDURE

The expansive soil sample and the expansive soil+fly ash sample were used in the laboratory investigations. The experiments were conducted on large-scale soil using fly ash that was obtained from a steel and thermal power plant. A range of fly ash particle percentages were investigated for the clay soil. The percentages are, in order, 0%, 5%, 10%, 15%, 20%, and 25%. In the lab, a soil sample was combined with fly ash and carefully mixed by hand. The following experiments were conducted using fly ash mixed with clay soil.

1) *Liquid Limit:* In accordance with the protocol outlined in IS: 2720 part 4(1970), the liquid limit test was carried out on expansive soil utilising Casagrandae's equipment.
2) *Plastic Limit:* Expanding soil was used for the Liquid limit test, which was carried out in accordance with IS: 2720 part 4 (1970).
3) *Proctor's Standard Compaction Test:* In accordance with IS: 2720 part 6(1974), a soil sample was prepared for the proctors compaction test.
4) *California Bearing Ratio:* 1973's IS 2720 (Part-10) of the soil testing procedures deals with determining the unconfined compressive strength.
5) *Unconfined Compressive Strength:* In accordance with IS 2720 part10 (1973), tests of unconfined compressive strength were carried out on expansive soil. In order to preserve the initial dry density and water content, all samples were processed using static compaction at OMC and maximum dry density. The soil was combined with fly ash in different volume proportions after contaminants were removed. The testing were performed in accordance with recognised protocols, and the mixing was meticulously completed by hand.

Table 3: Atterberg Limits of Soil – Fly Ash Mixture

Sl.No	Soil Type	Liquid Limit(%)	Plastic Limit (%)	Plasticity Index
1	Expansive soil	51	31.466	19.54
2	Expansive Soil + 5% FA	46	27.486	18.514
3	Expansive Soil+ 10% FA	41	24.02	16.98
4	Expansive Soil+ 15% FA	35	22.67	12.33
5	Expansive Soil+ 20% FA	33	21.30	11.70
6	Expansive Soil+ 25% FA	30	20.53	9.47

Table 3. Strength Properties of Soil – Fly Ash Mixtures

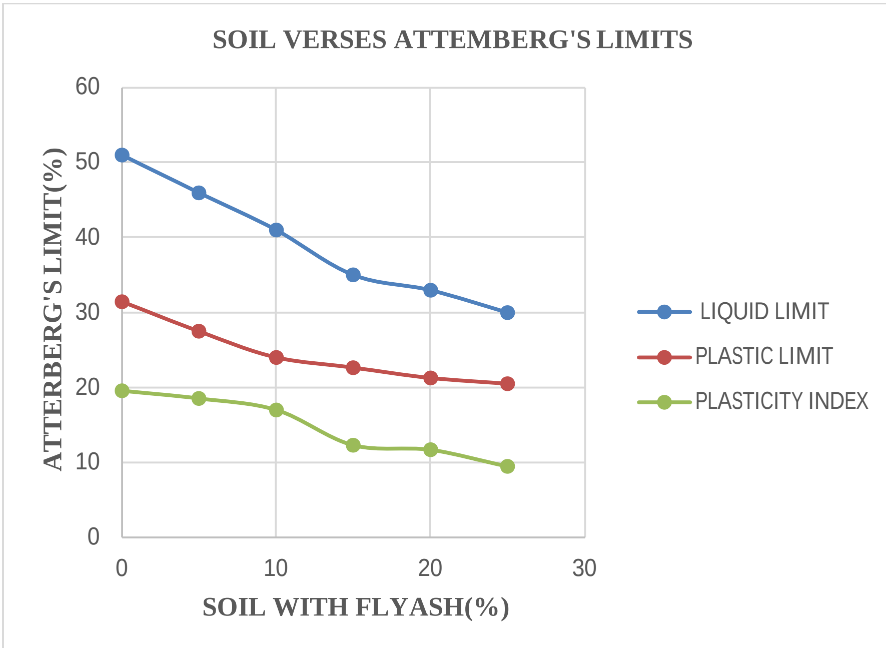
Soil type	OMC (%)	MDD (kN/m3)	UCS (kN/m2)	Permeaability(cm/sec)
Expansive soil	36	1.612	47.0	6.715x10^-6
Expansive Soil+5% FA	34	1.657	47.60	8.78x10^-6
Expansive Soil+10% FA	32	1.664	49	1.695x10^-5
Expansive Soil+ 15% FA	30	1.670	57	7.266x10^-5
Expansive Soil+ 20% FA	28	1.676	68	1.565x10^-4
Expansive Soil+ 25% FA	26	1.389	58	1.03x10^-3

V. RESULTS AND DISCUSSIONS

A. *Effect on Atterberg Limit*

Investigations have been done on the liquid and plastic limits of soil mixed with various amounts of fly ash.

In compliance with IS: 2720 (part 5) 1974 in the laboratory. Figure 2 shows that as fly ash characteristics increase, the soil's plastic limit value lowers.



B. *Effect on Strength Characteristics*

In compliance with IS 2720 (part 8) 1974, the compaction test was carried out on the expansive soil containing fly ash.

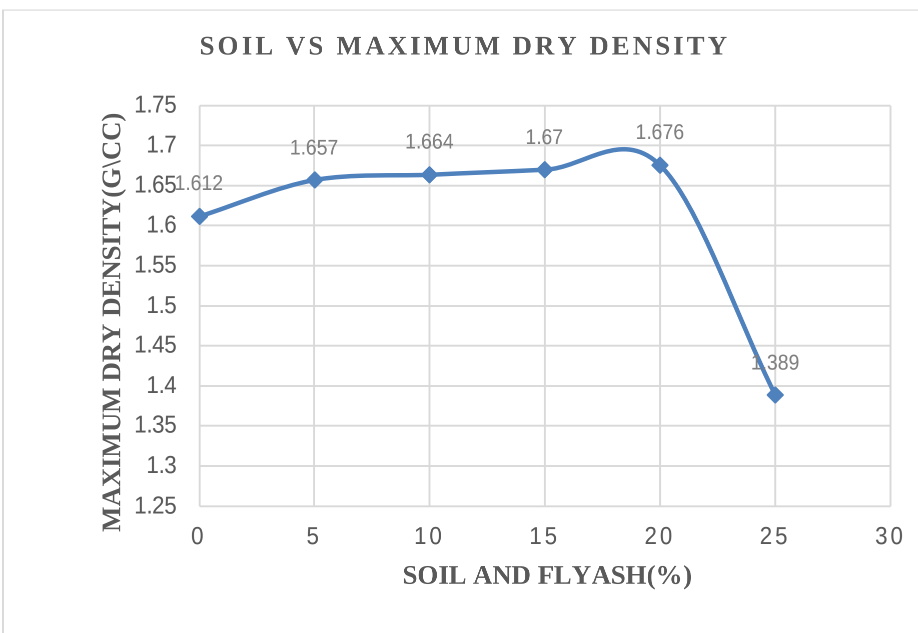


FIGURE 3

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The expansive soil containing fly ash now has an MDD of 1.676g/cc as opposed to 1.612g/cc.

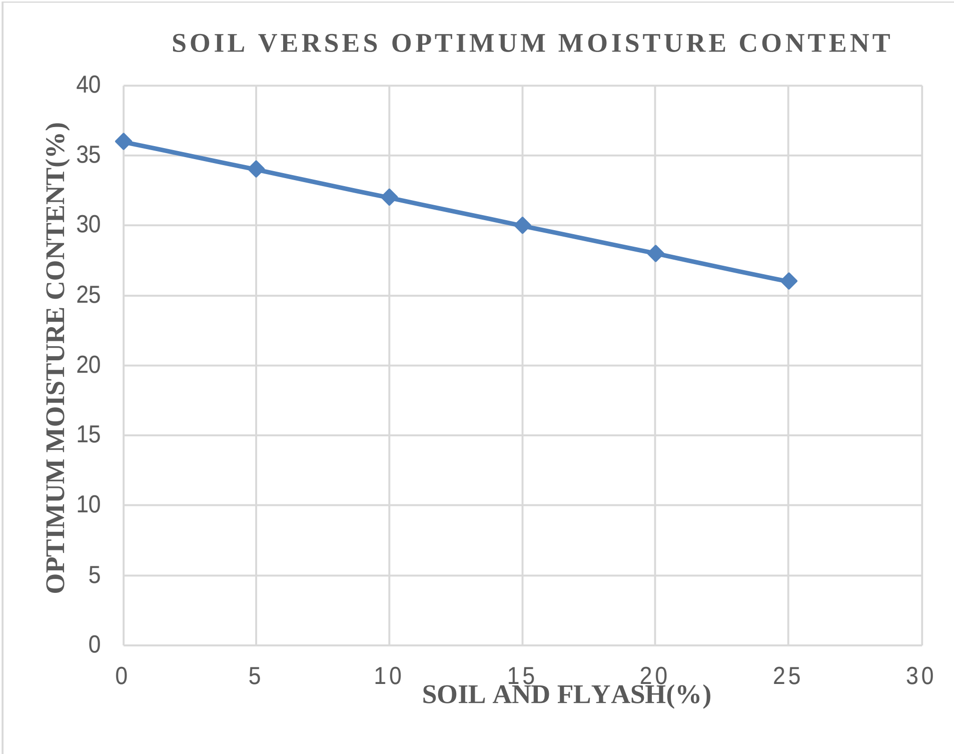


FIGURE 4

The drop in OMC content from 36% to 26% is depicted .

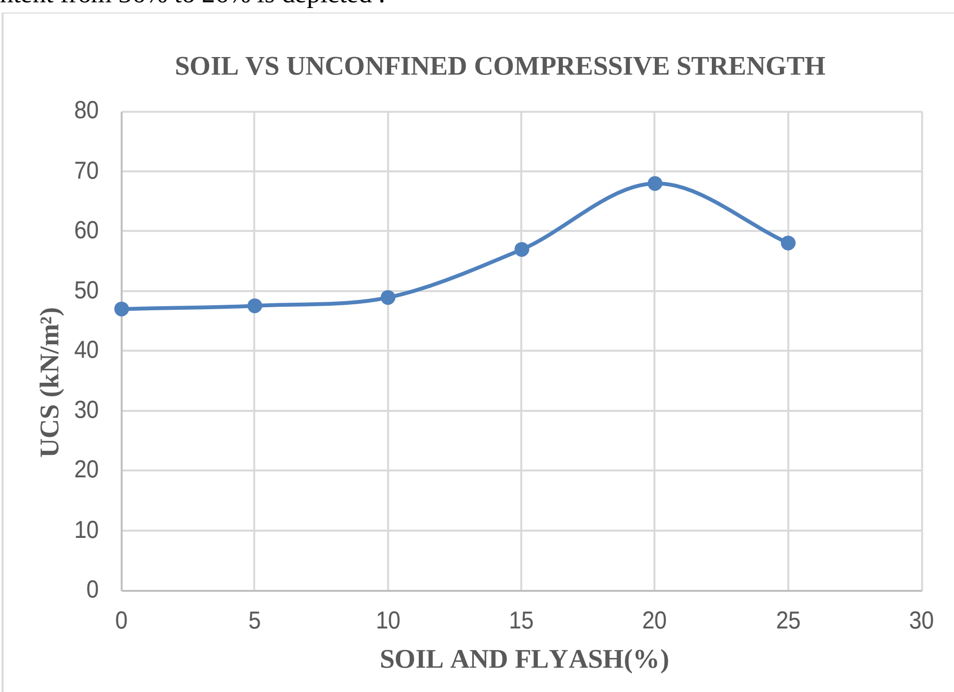
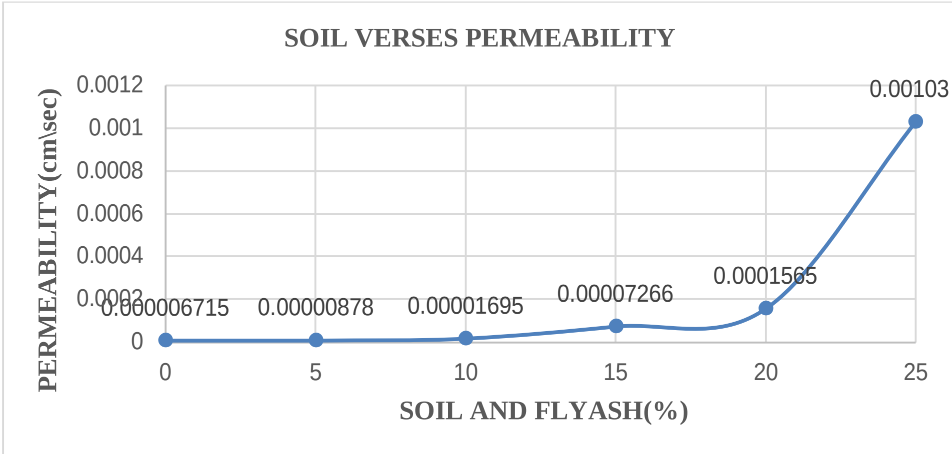


Figure 5

This is how adding 20% fly ash to the expansive clay raised its unconfined compressive strength from 47kN/m² to 68kN/m²



VI. FINAL COMMENTS

1) With the addition of fly ash, the unconfined compression strength of the specified soil sample increased by 44.68%.
2) The clayey soil sample's dry density is 3.97% higher than that of the natural soil sample.
3) The clayey soil sample's optimum moisture content is now 22.22% lower than that of the natural soil sample.