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STUDY ON SOME GEOTECHNICAL PROPERTIES OF ORGANIC SOIL STABILIZED WITH FLY ASH

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ABSTRACT

This paper represents the variation of plasticity, strength characteristics, compaction characteristics and acidic properties of organic soil stabilized with different percentages of fly ashes. The organic content of soil has bad impacts on its strength and other properties but it can be improved by stabilizing it with different types of ingredients. The amount of this improvement depends on the organic content of the soil as well as the quality and quantity of the stabilizer. In this study two types of fly ashes (Type-A and Type-B) were used as the soil stabilizer which were collected from two different cement factories. A lot of tests such as the Compaction tests, Atterberg Limit tests, Unconfined Compressive Strength tests for curing periods of 3 days, 7 days and 28 days and pH tests were performed on organic soil stabilized with 0%, 5%, 10% and 15% of both types of fly ashes. Analyzing the test results it is observed that the unconfined compressive strength, maximum dry density, pH, liquid limit and plastic limit increases gradually with increasing percentages of fly ashes which may be due to pozzolanic characteristics of fly ash. The unconfined compressive strength also increases with the increasing curing period. But the optimum moisture content and plasticity index decreases with the increasing percentages of fly ashes as the fly ashes were sufficiently dry and it had sufficient thirst to absorb water. It has also been found that the type-B fly ash stabilized organic soil can produce more strength and dry density than the type-A fly ash stabilized organic soil. The other properties of type-B fly ash stabilized soil also showed better improvement than type-A fly ash stabilized organic soil.

Keywords: *Stabilization, organic soil, compressive strength, fly ash stabilization*

1. INTRODUCTION

Soil is one of the most important and primary media for any construction work. The strength and durability of any structure depends on the strength properties of soil. It has been found from several studies that due to the detrimental characteristics of organic soil the strength and bearing capacity of this soil is very low. Khulna is the southwestern part of Bangladesh near the mangrove forest Sundarbans. It has been found that the organic soil exists here at a depth of 10 to 25 ft. below the existing ground surface and the organic content of this soil ranges from 5 to 70% and even more in some instances. As this organic soil exists so close to the ground surface the supporting power and the bearing capacity of this soil cannot be found at desirable level. Current practice for construction of roadways over organic soil subgrades *mostly* involve the removal of the organic soil to a sufficient depth and replacement with crushed rock (referred to as "cut and replace") or preloading to improve engineering properties. Chemical stabilization with binders such as cement, lime, and fly ash can be undertaken rapidly and often at low cost, and therefore chemical stabilization is becoming an important alternative (Keshawarz and Dutta 1993).

Stabilization is the process of blending and mixing materials with a soil to improve certain properties of the soil. The process may include the blending of soils to achieve a desired gradation or the mixing of commercially available additives which may alter the gradation or the mixing of commercially available additives that may alter the gradation, texture or plasticity or act as a binder for the cementation of soil. (J. Paul Guyer 2011)
Fly ash is one of the most effective binder as fly ash disperses the soil cement clusters into smaller clusters thereby increasing the reactive surface for hydration and pozzolanic reactions (Horpibulsuk et.al 2009) .Due to this pozzolanic characteristics the strength and bearing capacity of the organic soil can be increased by stabilizing it with fly ash. It can effectively stabilize soft inorganic soil but in case of organic soil this effectiveness is not so reasonable due to the organic content of soil (Ferguson 1993). In this study the properties of organic soil as well as the effectiveness of two different types of fly ashes to improve the strength and other engineering properties of the organic soil of Khulna regionis examined.

The main objectives of this study are given below:

(i) To obtain the initial properties of organic soil.

(ii) To determine the variation of maximum dry density and to obtain a relationship between the optimum water content and maximum dry density of organic soil admixed with different percentages of fly ash.

(iii) To examine the improvement of unconfined compressive strength of organic soil admixed with different percentages of fly ashes for different curing period.

(iv) To know the change in the acidic property of organic soil when admixed with different percentages of fly ashes.

(v) To investigate potentially important factors affecting the stabilization process, such as fly ash and soil characteristics, fly ash percentage in the mixture,water content and curing period.

2. MATERIALS AND METHODS

In this study disturbed organic soil and two types of fly ashes were used as the stabilizer.

2.1 Organic Soil:

The soil containing at least 30% of organic matter is known as organic soil. It is the gardening soil that contains the ingredients which have been certified as organic such as organic mulch.

The soil was collected from Beeldakatia, Shiromoni, Khulna from a depth of about 10 ft from the existing ground surface. The soil was taken in a large polythene bag and transported to the Geotechnical Engineering Laboratory of the department of Civil Engineering, Khulna University of Engineering and Technology (KUET), Khulna. Then the soil was dried in air for about 7 days and physical and index properties were determined. The index properties of soil are presented in table 1.

Table 1: Index properties of soil

Property Name	Values	Property Name	Values
Unit weight (kN/m^3)	11.17	Maximum dry density, γ_d (kN/m^3)	8.0
Liquid limit, w_L (%)	85.2	Specific gravity, G_s	2.19
Plastic limit, w_P (%)	62.53	pH	6.37
Plasticity Index, I_p(%)	22.67	Organic content(%)	36.9
Shrinkage limit, w_s(%)	28.19	Water content, w (%)	87.12
Shrinkage ratio, SR	1.24		

2.2 Fly Ash

Fly ash is a very fine, powdery material, composed mostly of silica which is a product of burning finely ground coal in a boiler to produce electricity.

Two types of fly ash denoted as type-A and type-B were used in this study.which were collected from two different cement factories and prepared for the test.

2.3 Tests Performed

A series of liquid limit test, plastic limit test, compaction test, pH test and unconfined compressive strength test for curing periods of 3 days, 7 days and 28 days were performed on untreated soil as well as organic soil stabilized with 5%,10% and 15% of fly ash.

A flow chart for the laboratory investigation procedure is presented in Figure-1

2.4 Laboratory investigation procedure

Figure 1: Flow Chart of Laboratory Investigation.

3. RESULTS AND DISCUSSIONS

A lot of tests were performed in the Geotechnical and Environmental Engineering laboratories and the effects of different types of fly ashes on geotechnical properties oforganic soil such as the plasticity, Compaction Characteristics, Strength properties and Acidic properties obtained from different test results are presented here.

3.1 Plasticity

The Atterberg limit tests were performed to obtain the plasticity of the organic soil admixed with different percentages of both types of fly ash content. Atterberg limits are the basic measure of the critical water contents of a fine-grained soil, such as its plastic limit, and liquid limit.

3.1.1 Liquid Limit and Plastic Limit

Variations of liquid limit and plastic limit with different percentages of fly ashes are presented in the graphical form.

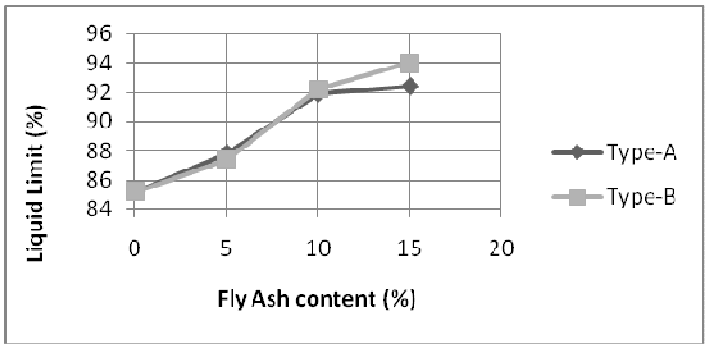

Figure 1: Variation of Liquid limit with different percentages of both types of fly ash content for BeelDakatia soil.

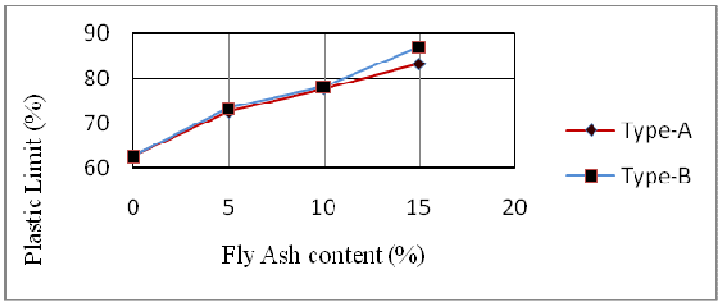

Figure 2: Variation of Plastic limit with different percentages of both types of fly ash content for BeelDakatia soil.

From the figure it has been found that both liquid limit and plastic limit of the organic soil increase with the increasing percentages of both types of fly ashes.

3.1.2 Plasticity Index

The plasticity index decreases with the increasing percentages of both types of fly ashes and it has been found that type-A fly ash stabilized organic soil gives higher values of plasticity index than type-B stabilized organic soil.

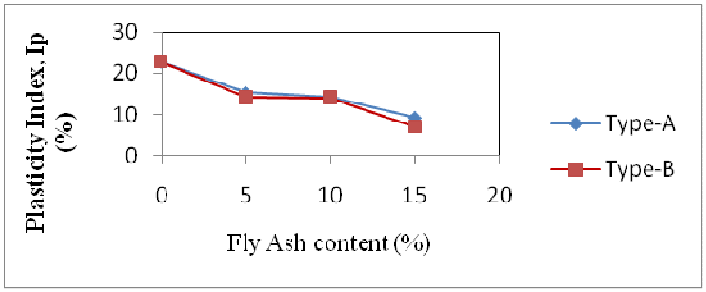

Figure 3: Variation of Plasticity index with different percentages of both types of fly ash contents for BeelDakatia soil.

As fly ash is a dry admixture and it's tendency to absorb water is not so negligible, the plasticity index reduces as the percentages of fly ash is increased.

3.2 Compaction Characteristics:

A series of compaction tests were performed on untreated soil and the soil treated with 5%, 10% and 15% of fly ash of both types and finally from the dry density versus moisture content curve the maximum dry density and optimum moisture content were determined.

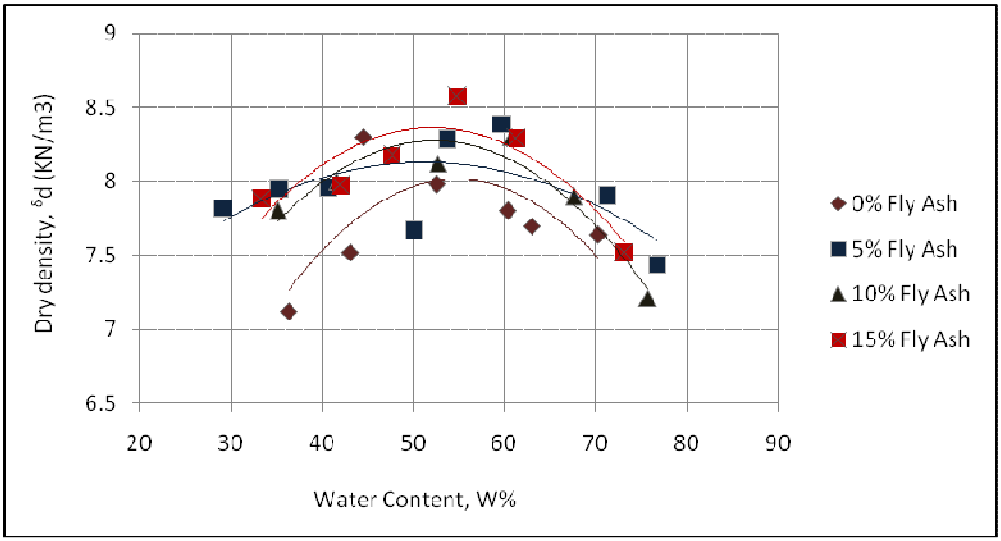

Figure 4: Dry density vs. moisture content curve for BeelDakatia soil treated with different percentages oftype-A fly ash .

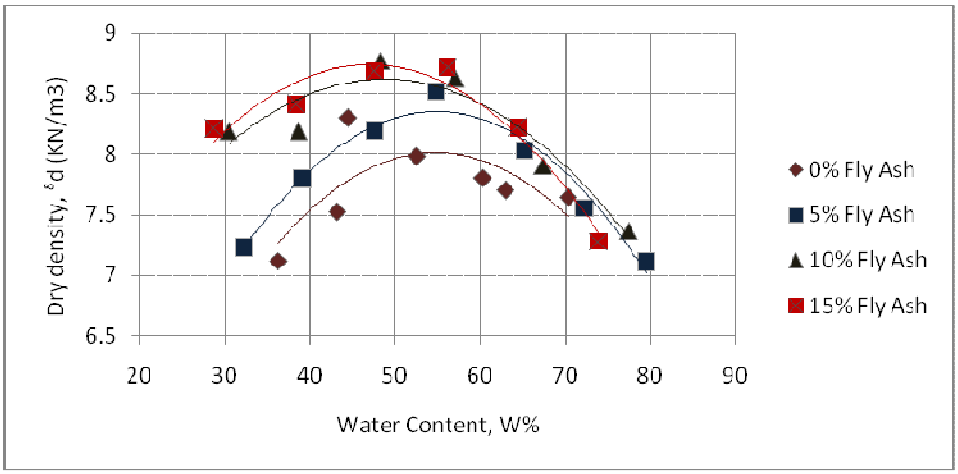

Figure 5: Dry density vs. moisture content curve for BeelDakatia soil treated with different percentages of type-B fly ash.

It is found that the dry density increases with the increasing percentages of fly ash content and after a certain percentages of water content it started to decrease which is known as the optimum moisture content and the dry density at this moisture content is known as the maximum dry density. The variation of maximum dry density with different percentages of both types of fly ash content is presented in figure 6.

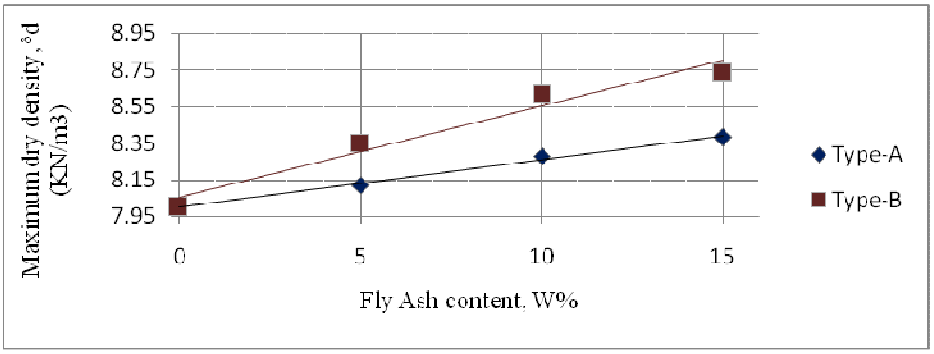

Figure 6 : Variation of maximum dry density with different percentages of both types of fly ash content.

Figure 6 shows that the maximum dry density increases with the increasing percentages of both types of fly ashes and the optimum value of fly ash content is yet not found. It is also clear from figure 6 that the maximum dry density increases more significantly for type B fly ash stabilized organic soil than type A fly ash stabilized organic soil.

3.3 Strength Characteristics

A series of unconfined compressive strength test were performed on different percentages of fly ash stabilized organic soil for different curing periods and test results are presented in the graphical form.

3.3.1 Effect of types fly ash on strength

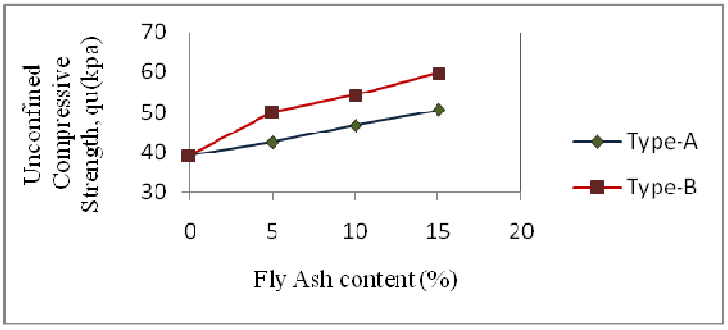

Figure 7 : Variation of Unconfined Compressive Strength with varying percentages of both types of fly ash for curing period of 3 days.

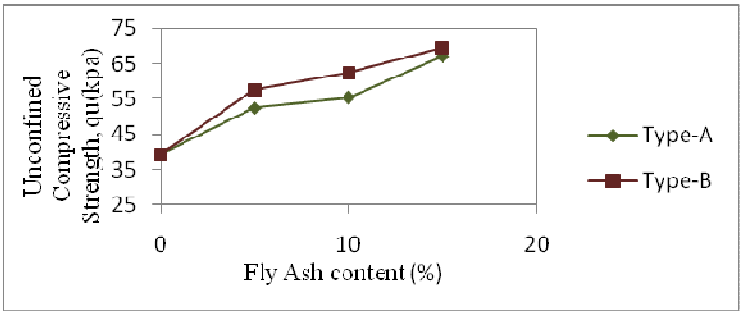

Figure 8 : Variation of Unconfined Compressive Strength with varying percentages of both types of fly ash for curing period of 7 days.

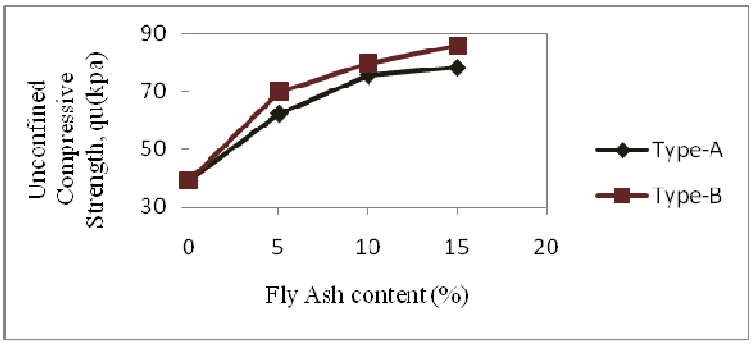

Figure 9 : Variation of Unconfined Compressive Strength with varying percentages of both types of fly ash for curing period of 28 days.

The variation of unconfined compressive strength with different percentages of fly ash for curing period 3 days, 7 days and 28 days are presented on figure 7, 8 and 9 respectively. In each case it is found that the unconfined compressive strength increases with the increasing percentages of fly ash and type-B fly ash stabilized organic soil can produce greater unconfined compressive strength than type-A fly ash stabilized organic soil.

3.3.2 Strength development with curing period

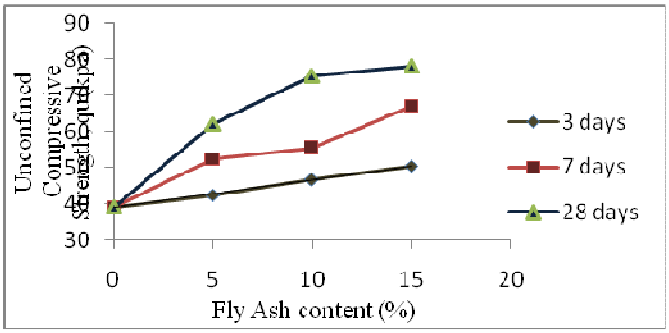

Figure 10: Variation of Unconfined Compressive Strength with varying percentages of type-A fly ash for different curing periods.

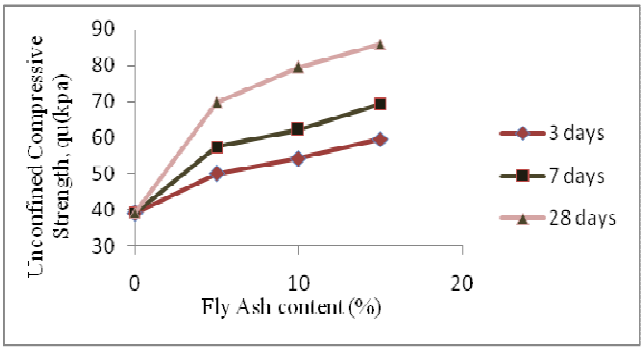

Figure 11: Variation of Unconfined Compressive Strength with varying percentages of type-B fly ash for different curing periods.

Variation of unconfined compressive strength with fly ash content are presented on figure 10 and figure 11. From the test results it is found that the unconfined compressive strength of organic soil increases with the increasing curing period.It has been obtained that 15% type-B fly ash stabilized organic soil can produce

maximum unconfined compressive strength of 85.84 kpa for a curing period of 28 days where 15% type A fly ash stabilized organic soil can produce 78.27 kpa unconfined compressive strength for the 28 days curing period.

3.3 pH Test :

Tests were performed to determine the acidic property of the organic soil for different percentages of fly ash content was tested in Environmental Engineering laboratory and the test results are presented here in graphical form.

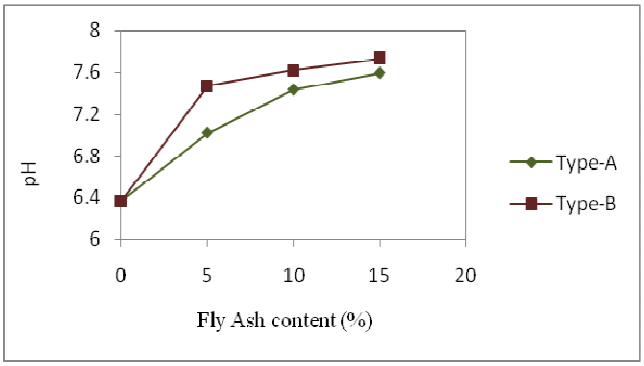

Figure 4.28 : Variation of pH with varying percentages of both types of fly ash.

The acidic property of both types of stabilized soil slightly decreaseswith the increasing percentages of fly ash content.

4 CONCLUSIONS

Fly ash stabilization is one of the inexpensive way to improve the geotechnical properties of soil. In this study a series of different types of tests are conducted to quantify the improvement of the quality of soil.
Based on the test results the following conclusions can be drawn:

- The moisture content decreases and the dry density increases gradually for addition of both types of fly ash with the organic soil .
- Both the values of liquid limit and plastic limit increase and the plasticity index decreases with increasing percentages of both types of fly ash content.
- The unconfined compressive strength increases with the increasing percentages of fly ash content for both types of fly ash.
- The unconfined compressive strength also increases with the increase of curing period.
- The pH value increases with the increasing percentages of fly ash content for both types of fly ash stabilized organic soil.
- The type-B fly ash stabilized organic soil can produce more strength and dry density than the type-A fly ash stabilized organic soil. So the type-B fly ash is preferable totype-A fly ash in order to improve the quality of soil.

Finally it can be said that the properties of organic soil can be improved by using fly ash but the amount of this improvement depends on the characteristics of organic soil as well as the properties and the amount of fly ash. Further study is required to obtain the optimum amount of fly ash.

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