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# Strength Characteristics of Stabilized Peat Soil using Fly Ash

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***Abstract*— Stabilization of soft and weak soils is considered as an effective method to improve the strength characteristics of the soil. Removal and replacement of the soil involves high cost. Peat soil is considered as one of the soft soils where the construction is difficult. This paper describes the stabilization of peat soil with objective to improve the strength of the soil by treating it with fly ash. Fly ash is an industrial by product that is relatively inexpensive. As the demand for land is increasing day by day, it is necessary to make use of the available area effectively.**

***Index Terms*— Peat soil, stabilization, fly ash, unconfined compressive strength**

## I. INTRODUCTION

Peat is considered as an extreme form of soft soil and also weak. Thus in most cases constructions on these soils are avoided. These soils are found in many countries throughout the world. In general, peat is mainly composed of fibrous organic matters, i.e. partly decomposed plants such as leaves and stems. Peat has largely organic residues of plants, incompletely decomposed through lack of oxygen. Peat is identified as a very soft and difficult soil with low shear strength, high organic matter, low bearing capacity and high compressibility. These characteristics cause excessive settlement which is very challenging to geotechnical engineers and the construction industry at large. Due to this problematic nature of peat soil, construction on it becomes a very challenging task to geotechnical and civil engineers and hence, the engineers regarded peat soil as the worst foundation soil for supporting the structures founded on it because of its unfavorable nature and behavior. Peat actually represents an accumulation of disintegrated plant remains, which have been preserved under condition of incomplete aeration and high water content. It accumulates wherever the conditions are suitable, that is, in areas with excess rainfall and the ground are poorly drained, irrespective of latitude or altitude. Peat deposits tend to be most common in those regions with comparatively cool wet climate. As demand for land increases and its supply becomes limited, constructions on weak soil such as peat cannot be avoided. There are many researches taking place to find the best method of stabilizing and improving peat soil. The methods are mainly concentrating on modification and stabilization of peat soil. The purpose of stabilizing and modifying peat soil is to improve its ability to perform well by increasing its strength and decreasing the excessive settlement when such soil is subjected to loads from structures [2]. Most common way for soft or peat soil treatment is by excavating the soft or peat soil and replacing it with good granular or sandy soil but this way of soil treatment is not encouraged because of the uneconomical

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design. If heavy loaded buildings are to be constructed on a soft peat soil layers, piled foundations can be used to transfer the loading to the rock. But if lightly loaded buildings are to be constructed, it is not economical to construct the structures on piled foundations. Deformation of a peat soil is influenced by the orientation of solid particles in the soil. This arrangement of the particles controlled the way the particles are deposited. The particles arrangement influences the rate of water flow as water tries to escape from soil under loading.

Fly ash, the most widely used supplementary cementitious material in concrete, is a by product of the combustion of pulverized coal in electric power generating plants. Upon ignition in the furnace, most of the volatile matter and carbon in the coal are burned off. During combustion, the coal's mineral impurities (such as clay, feldspar, quartz, and shale) fuse in suspension and are carried away from the combustion chamber by the exhaust gases. In the process, the fused material cools and solidifies into spherical glassy particles called fly ash. The fly ash is then collected from the exhaust gases by electrostatic precipitators or bag filters. Fly ash is a finely divided powder resembling portland cement.

## II. Materials

The soil sample was collected from Ooty, Nilgiris district, Tamilnadu. The site was a water logged area. In the site visited, it was noticed that climatic factors such as temperature, humidity, rainfall, among others are the most important factors beyond peat soil formation and development. These factors are found to have direct and indirect influence on peat soil formation, development and its characteristics. Among these climatic factors, humidity and temperature were identified as the most important factors that facilitate the decomposition, transformation and development of organic matter. The soil sample collected was black to dark-brown in colour and is very spongy. The materials used for the work are soil sample and fly ash.

## III. Test Programs

Tests were conducted to examine the effect of fly ash in the strength characteristics of peat soil. The strength of soil without any addition of binder is evaluated to determine the percentage in increase after treating the soil with fly ash.

The amount of fly ash added to the peat soil sample as a percentage of the dry soil mass, were in the range of 10-30%.

## IV. Results and Discussions

The different properties of virgin soil are evaluated before it is subjected to any treatment. The knowledge of strength characteristics of untreated peat soil helps to determine the percentage increase in the strength of the soil by the addition of fly ash. The basic properties of peat soil is given in Table I.

From the test, it is determined that the soil is rich in peat. If the organic content of the soil is less than 15%, it can be termed as Class II peat [15]. The unconfined compressive strength of the soil sample implies that the soil is very soft and is not capable to carry even moderate loads. The soil is treated with different percentages of fly ash such as 10%, 15%, 20%, 25% and 30% of the weight of the dry soil mass.

TABLE I- BASIC PROPERTIES OF PEAT SOIL

| Description | Values |
|---|---|
| Water content (%) | 43.45 % |
| Organic matter content (%) | 12.5 % |
| Free swell index | Low |
| Specific gravity | 2.0 |
| Optimum moisture content (%) | 15 % |
| Maximum dry density (g/cc) | 1.77 g/cc |
| Unconfined compressive strength, $q_U$ | 20.9kN/m$^2$ |
| Shear strength, $q_U/2$ | 10.5 kN/m$^2$ |

The fly ash is incorporated with the soil mass as an addition to the total weight of the untreated soil. The variation in optimum moisture content and maximum dry density of the soil with different percentages of fly ash is shown in the table II.

Table II- Variation in OMC and MDD with Different Percentages of Fly Ash

| Description | OMC (%) | MDD ($g/cm^3$) |
|---|---|---|
| Soil + 0% fly ash | 14.4 | 1.77 |
| Soil + 10% fly ash | 25.9 | 1.44 |
| Soil + 15% fly ash | 27.27 | 1.42 |
| Soil + 20% fly ash | 28.0 | 1.39 |
| Soil + 25% fly ash | 29.1 | 1.32 |
| Soil + 30% fly ash | 22.2 | 1.46 |

While fly ash is added, the optimum moisture content of the sample increased upto 25% fly ash and then it decreased, which is shown in figure 1. Likewise the maximum dry density of the sample decreased and then it increased at 30% fly ash, shown in figure 2.

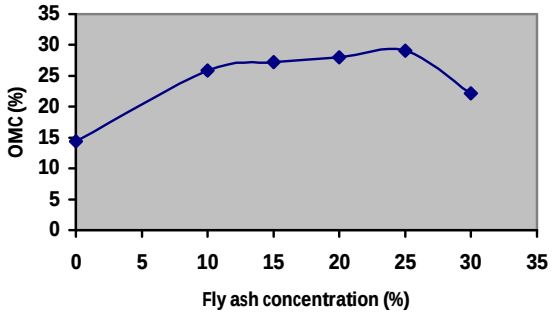


Figure 1- Curve showing variation in OMC with different percentages of fly ash

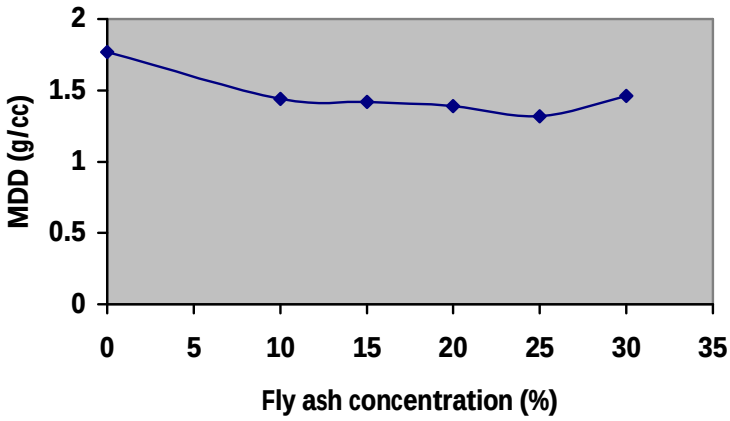


Figure 2-Curve showing variation in MDD with different percentages of fly ash

## V. Unconfined Compressive Strength

When dealing with the strength characteristics of the soil alone and with the addition of fly ash, unconfined compression test is conducted. The preparation of sample for the unconfined compression test faced several difficulties which again indicates the less strength of the soil. The increase in the unconfined compression value of the soil for each percentages of fly ash is shown in Table 3. The results shows that there is a gradual

increase in the strength value by the addition of fly ash. While adding 30% fly ash to the soil, there is an overall increase in the soil by about 68%. It is because when fly ash is added to the soil mass, the voids in the soil mass is reduced. This increases the strength of the soil mass creating an adequate bonding.

TABLE III – THE UNCONFINED COMPRESSIVE STRENGTH VALUE FOR DIFFERENT PERCENTAGES OF FLY ASH

| Description | Unconfined compressive strength, $q_u$ ($kN/m^2$) |
|---|---|
| Soil + 0 % fly ash | 20.9 |
| Soil + 10 % fly ash | 21.9 |
| Soil + 15 % fly ash | 26.6 |
| Soil + 20 % fly ash | 27.4 |
| Soil + 25 % fly ash | 30.4 |
| Soil + 30 % fly ash | 35.0 |

## V. CONCLUSIONS

Stabilization of soft soils improves the engineering and index properties of soils. Peat soil is considered as a soft and weak soil which has low strength, low load bearing capacity and high compressibility. Therefore the stabilization of peat soil by suitable means increases the effectiveness of the soil. Fly ash is an industrial by product which is easily available and is economical. The disposal of fly ash is an environmental issue which can be solved to an extent by using it in the stabilization purpose. It seems that while adding the fly ash to the soil the properties of soil increases. The strength of the soil is increased up to 70% by the addition of 30% of fly ash.

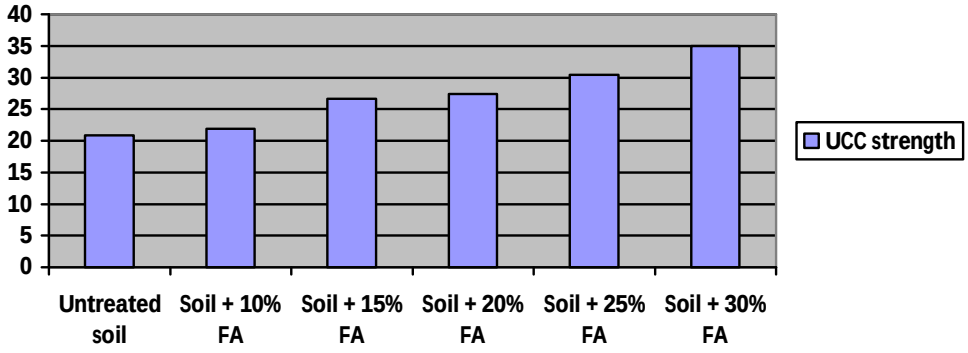


Figure 3- Barchart showing the strength values for different percentages of fly ash

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