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Study of Geotechnical Parameters of Soil on Partial Replacement with Fly ash

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ABSTRACT

Soil behaves like a peculiar material. When we study the different parameter we analyze that soil is not so capable to perform any heavy construction work like sub grade pavement and foundation work. After adding some materials by which enhance the physical as well as chemical properties of the clayey soil. Some waste and byproduct materials such as Fly ash may be used to provide the soil stable. To keep that think in mind, so we need to improve the geotechnical parameter of soil with adding small amount of fly ash (as an admixture). Fly ash is mixed with the soil in different (0%, 5%, 10% and 15%) percentages by weight of soil and study the behavior of the Geotechnical parameter. Some of the important and most effective methods are used to provide soil stable with adding a little amount of flyash.

Some predated properties which will improved are liquidity index, plasticity index, unconfined compressive strength, CBR value, shear strength, and bearing capacity etc. The main objective of this study is to compare the effect of Fly Ash which is derived from combustion of coal at electric power plants which adding in soft fine-grained clayey soils. CBR and other strength property tests were conducted on soil.

Keywords –Clayey soil, flyash, Geotechnical properties of soil and various apparatus related to their tests.

I.INTRODUCTION

When construction in a marshy area, it is found that the whole area is covered with plastic clay having liquid limit varying from 30 to 50%. The whole area is not so capable to carry heavy load. The soil is not suitable for construction due to the following reasons which is given below:

1. It has a poor workability for compaction. Then optimum moisture content cannot be achieved during monsoon.
2. It has high compressibility and leading to top settlement.
3. Lake of shear strength for required slope stability.

Instead of borrowing a suitability of soil from a long distance, it provide a proposal to use the locally available plastic clay soil after partially replacement with fly ash that is available in the thermal electric power plant. A detailed literature review is carried out on the subject that is followed by various tests. This paper defines the various variations in properties of natural clay, stabilized clay with varying percentage of fly ash and tests

carried out in the natural soil and mixing with different percentage of fly ash. The procedure adopted for mixing the soil with fly ash in the laboratory and the test results have been defined.

II.LITERATURE REVIEW

Fly ash has little cementatious value but in the presence of some amounts moisture it can react chemically and forms cementatious compounds and it can be used to enhance the strength and compressibility characteristics of soils. It has a better history of use as an engineering material and has successfully employed in geotechnical applications.

Erdal Cokca (2001): Erdal Cokca was studied the effect of Flyash on expansive soil. Flyash consist of silicon, aluminum and iron oxides and carbon compounds. Class C and class F are two major classes of flyash. It is produced from burning bituminous coal and then it is produced from burning lignite and sub bituminous coal in thermal electric power plant. Class C and class F are puzzolans in nature, which are defined as siliceous and aluminous materials. Thus Fly ash can provide combinations of divalent and trivalent cations of Ca2+,Al3+,Fe3+etc under ionized conditions which can be promote flocculation of dispersed clay particles. Then expansive clayey soils can be getting stability by cation exchange using fly ash. So he carried out investigations using Soma.

Flyash is added to black cotton clayey soil at 0-25%. Specimens with flyash have cured for 7days and 28 days after which they were subjected to Odometers free swell tests. And his experimental findings confirmed that the plasticity index, activity and swelling potential of the samples decreased with increasing percent stabilizer and curing time and the optimum content of flyash in decreasing the swell potential was found to be 20%. The changes in the physical properties and swelling potential is a result of additional silt size particles to some extent and due to chemical reactions that cause immediate flocculation of clay particles and the time dependent puzzolanic and self hardening properties of flyash and he concluded that both high –calcium and low calcium class C fly ashes can be recommended as effective stabilizing agents for improvement for improvement of expansive soils

Pandian et.al. (2002). He Studied the effect of two types of fly ashes that are Class F and Class C on the CBR and other geotechnical characteristics of the expansive black cotton soil. The amount of fly ash content was enhancing from 0 to 100%. The CBR and shear strength is contributed by soils friction and cohesion parameters. The value of California bearing ratio (CBR) of black cotton soil, which consists of finer particles, can contributed by cohesion parameters. The California bearing ratio (CBR) of fly ash, which consists of coarser particles, can contribute by its frictional parameter. The low California bearing ratio (CBR) of black cotton soil is contribute to lower strength, which can due to determine the clay fraction. But when he added a little amount of fly ash to black expansive soil increases the California bearing ratio (CBR) of the adding to the first its optimum level due to the frictional resistance from fly ash in addition to the cohesion from black expansive clayey soil.

But if adding the amount of fly ash beyond the optimum level causes California bearing ratio (CBR) and shear strength about 60% and then the next optimum level there is an increase. Thus the variation of low California bearing ratio (CBR) of fly ash- black cotton soil mixes can be contributes to the relative contribution of cohesive and frictional resistance from fly ash or BC soil, respectively. In C class fly ash also there is an enhance of strength with the increasing the amount of fly ash content, then there will be additional chemical reaction forming cementitious compounds resulting in good binding between black cotton soil and variable amount of fly ash particles.

Phanikumar and Sharma (2004): Phanikumar and Sharma were carried out by and the effect of fly ash on engineering properties of expansive soil through an experimental program. The effect on parameters like free swell index (FSI), swell potential, swelling pressure, plasticity, compaction, strength and hydraulic conductivity of expansive soil was studied. The ash blended expansive soil with flyash contents of 0, 5, 10, 15 and 20% on a dry weight basis and they inferred that increase in flyash content reduces plasticity characteristics and the FSI was reduced by about 50% by the addition of 20% fly ash. The hydraulic conductivity of expansive soils mixed with flyash decreases with an increase in flyash content, due to the increase in maximum dry unit weight with an increase in flyash content. When the flyash content increases there is a decrease in the optimum moisture content and the maximum dry unit weight increases. The effect of fly ash is akin to the increased compactive effort. Hence the expansive soil is rendered more stable. The undrained shear strength of the expansive soil blended with flyash increases with the increase in the ash content.

III.LABORATORY TESTS

Following laboratory tests have been carried out as per IS: 2720. The tests were carried out both on virgin soil and different proportion of flyash added with the soil collected from Thermal Power Plant.

1. Water content Test
2. Specific Gravity Test
3. liquid Limit Test
4. Plastic Limit Test
5. Compaction characteristics Test
6. Permeability Test
7. Unconfined compressive strength Test
8. CBR Test

IV.RESULT

There are few results which we get after performing the laboratory tests.

1. Water content test

The water content is defined as the ratio of the mass of water to the mass of solid. After performing our test with varying percentage of fly ash we get the result with is graphical form. From the graph it is clear the as well as the amount of flyash increases the water content is reduces.

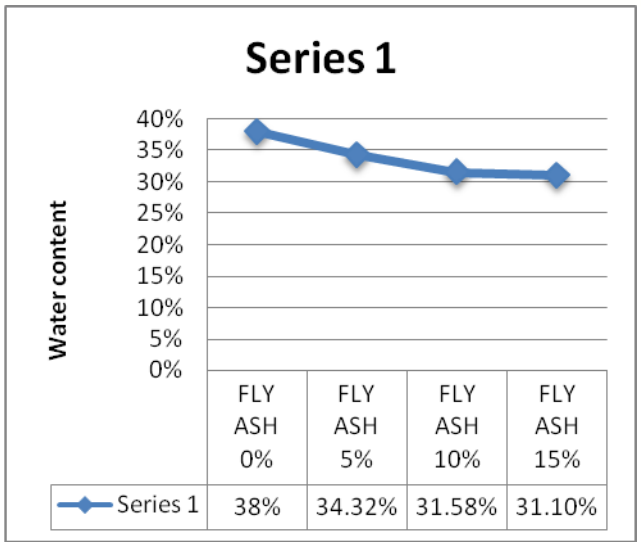

Fig (1) oven dry test

2. Specific gravity test

Specific gravity may be defined as the ratio of the mass of the given volume of the soil to the mass of an equal volume of the water at 4*c.

The specific gravity of a soil is providing a relationship of air, water and solids in a volume of the soil.

In our studies we observe that as well as we increase the amount of the flyash from 0 to 15% the value of the specific gravity is decreases from 2.67 to 2.17.

3. Liquid limit test

Liquid limit may be defined as a water content at which the soil changes from the liquid state to plastic state.

In other words it is the water content (%) at which the soil will just start to flow when subjected to standard shaking test. In our test we observe that as well as we increase the amount the percentage of flyash from 0 to 15%, the moisture content of the sample reduces from 36.28% to 30.93%

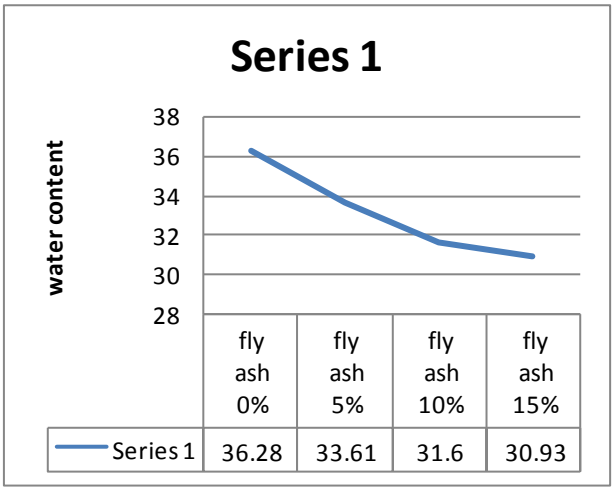

Fig (3) liquid limit test

4. Plastic limit test

It is the water content below at which soil moves to limit state to the plastic state and behaving as a plastic material. It starts to crumble when rolled into a thin wire of 3-2.5 mm dia. At this state, it loses its plasticity and moves to semi solid state. In our studies we find that whenever we increase the little amount of flyash from 0 to 15% then the moisture content increases from 23.05% to 29.53%

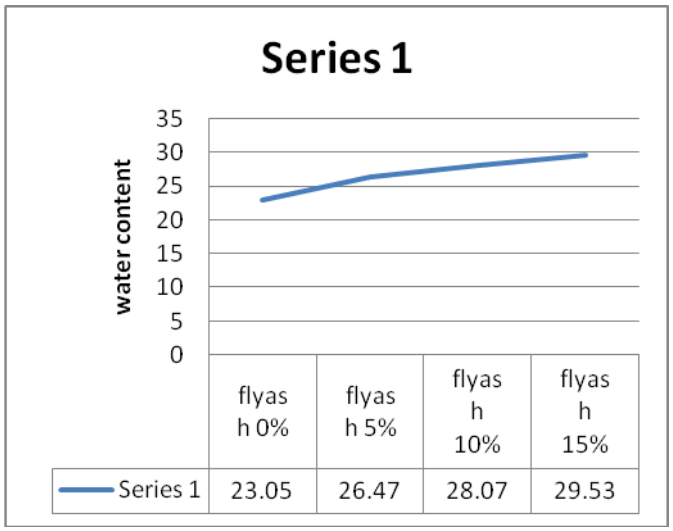

Fig (4) plastic limit test

5. COMPACTION CHARACTERISTICS

Compaction may be defined as process of enhancing the bulk density of soil or aggregate by Soil compaction occurs when its particles are pressed together, decreasing pore spaces between soil particles. The decreasement of soil pore spaces is getting by reducing air void space. In compaction process only air void is reduces but water content is not affected. As well we increasing the amount of flyash the optimum moisture content reduce and the maximum dry density is achieved between 5% and 10% amount of flyash.

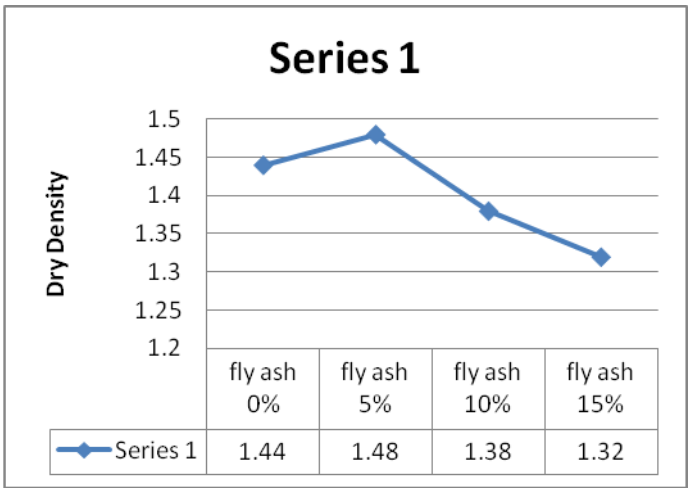

Fig (5) compaction characteristics of soil test

6. Permeability test

Permeability is most important phenomena in solving problems involving yield of water bearing strata, seepage of water through soil in earthen dams, stability. Permeability method followed in this standard (Part-XVII) defines the laboratory determination of the coefficient of permeability of soils. This test is recommended in IS code for clayey soils with coefficient of permeability in the range of 10^{-6}-10^{-8}. In the present determinations falling head method is employed.

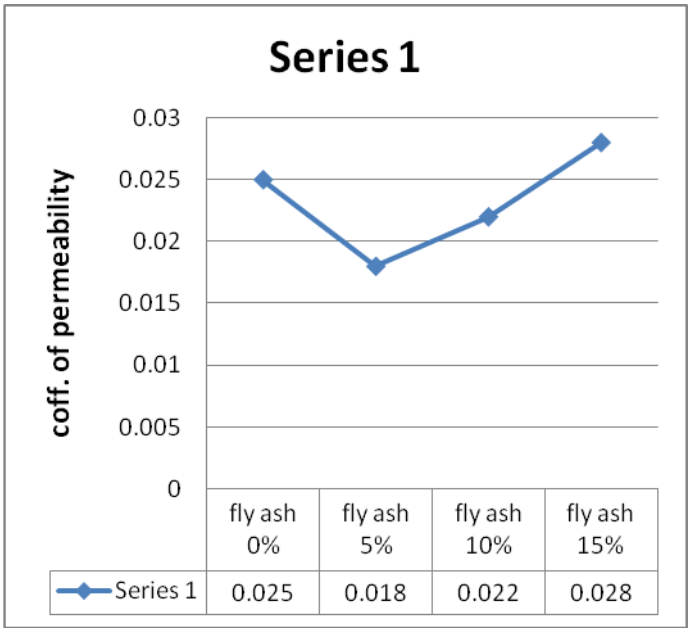

Fig (6) falling head permeability test

7. UNCONFINED COMPRESSION TEST (IS 2720-3-1)

It is used to determine the shear parameters of cohesive soil. Defined as the load per unit area at which an unconfined prismatic or cylindrical specimen of standard dimensions of soil failed in a sample.

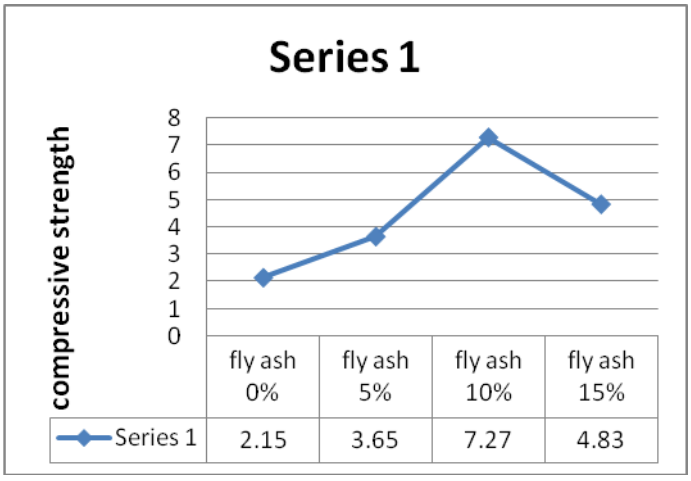

Fig (7) unconfined compressive strength of the soil test

8. California Bearing Ratio (CBR) (IS: 2720 Part 16 -1973)

The California bearing ratio (CBR) is a penetration test for evaluation of the mechanical strength of road sub grades and base courses. It was developed by the California Department of Transportation. This test is performed by measuring the pressure required to penetrate a soil sample with a plunger of standard area. The measured pressure is then divided by the pressure required to achieve an equal penetration on a standard crushed rock material

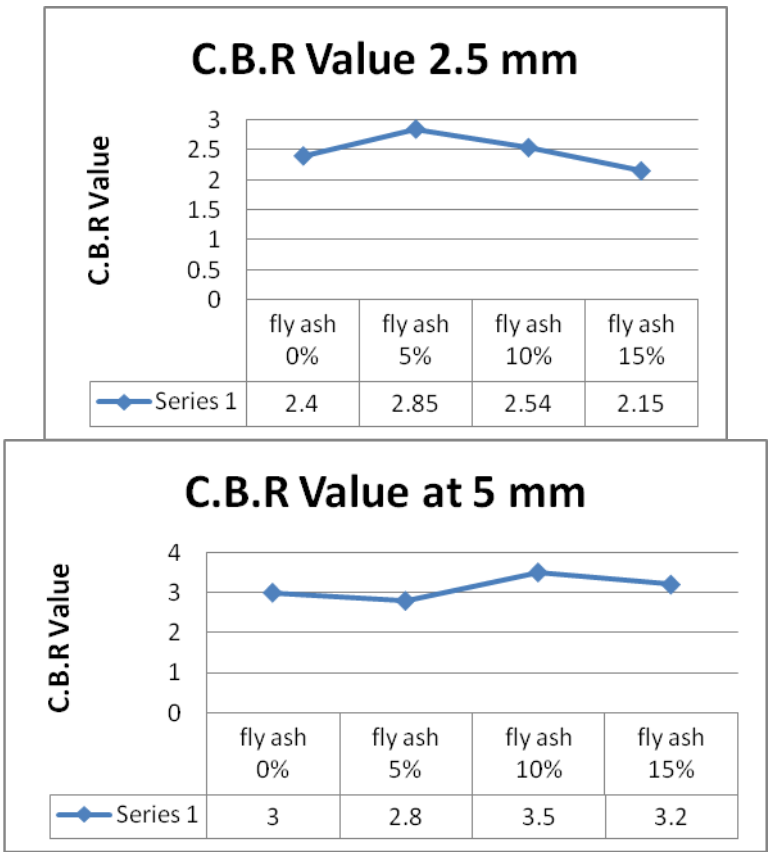

Fig (8) C.B.R Value at 2.5 and 5 mm depth test

V.CONCLUSION

There are few conclusions we get after study the clayey soil with partial replacement with flyash:

- As well as we increasing the amount of the flyash the natural water is reduce then we understand the chance of getting settlement is reduce.
- In the case of specific gravity we know that flyash is an organic material and it reduces the specific gravity of the clayey soil then we understand that the weight of soil is reduce so it reduce the chances of overturning of the soil.
- In the case of liquid limit and plastic limit as well as we increase the amount of the flyash it affect the both limits, liquidity is reduces and plasticity is increases.

- For the compaction characteristics of the clayey soil, the M.C. is increase initially but at o.m.c it stable and after it, it decrease as we increasing the amount of the flyash.
- Similarly as the above case, in unconfined compressive strength of the soil initially increases it maximum limit and after getting maximum value then it reduces.
- Permeability of the clayey soil is initially increase but at the excessive amount of the flyash the permeability of the soil is reduces.
- C.B.R value the virgin soil is minimum but as well as increasing the amount of the flyash C.B.R value is increase but at the excessive amount of the flyash its C.B.R. value is reduce.

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