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COMPARE THE ENGINEERING PROPERTIES OF BLACK COTTON SOIL WITH SOIL STABILIZED BY ALKALI ACTIVATED FLY ASH

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Abstract - *In India many types of soils are available and in all types of soil, black cotton soil also known as expansive soil was found most problematic soil. This kind of soil is mainly found in different states with different percentages such as Maharashtra (27%), Madhya Pradesh (21.3%), Gujarat (11.5), and Andhra Pradesh (7.1) in India. During the rainy season, this type of soil absorbs lots of water and it becomes soft while in hot weather it becomes harder like a rock due to evaporation of water. Due to its swell and shrink behavior, it cannot bear any kind of structural load and because of that, any type of structure construction is not possible on this soil. So that stabilization of soil is a must before doing any type of construction. This research deals with improving the geotechnical characteristics of Expansive soil (free swell index, liquid limit, plastic limit, plasticity index, MDD, and OMC) and increasing the CBR value of the soil by adding a different percentage of alkali-activated Fly ash. In this study, waste material fly ash with some alkali activator is used to stabilize black cotton soil. Sodium hydroxide (NaOH) concentration along with sodium silicate (Na_2SiO_3) is used as an alkali activator. The Na_2SiO_3/NaOH ratio is taken as 2. Fly ash is added to the normal soil with different percentages (10%, 20%, and 30%).*

Key Words: **Alkali Activated Fly Ash, Expansive soil, Geopolymer stabilization, CBR, SPT**

1. INTRODUCTION

Foundation is the most basic and most important part of any type of structure. Foundation on problematic soils is usually a concern in geotechnical engineering. Among many problematic soils, black cotton soil is one of the foremost problematic soil for a safe foundation style because of its behaviour. Black cotton soil known as problematic soil was found in Maharashtra, Madhya Pradesh, Gujarat, and Andhra Pradesh in India.

Due to that reason stabilization of expansive soil most important topic in geotechnical engineering. In this present paper, alkali-activated fly ash is used to improve black cotton soil. For this research waste material fly ash is used as binder material was collected from a thermal station and sodium hydroxide and sodium silicate is used as alkali activators to improve geotechnical properties of Black cotton soil rather than ordinary Portland cement (OPC).

In this study, NaOH was prepared by mixing sodium hydroxide pallets with distilled water at 10M concentration and 1 mole of sodium silicate solution was prepared by adding 284.20gm of sodium silicate powder to 1 liter of distilled water. The Na_2SiO_3/NaOH ratio is taken as 2. And 10% of alkali activator is added in soil. The amount of Fly ash is varied from 10%, 20%, and 30 %.

2. MATERIAL

Expansive soil

Expansive soil used for this study was collected from Kadana District, Mahisagar, Gujarat. The soil was air-dried, pulverized, and sieved with 4.75 mm Indian standard as required for laboratory tests.

Fly Ash

Fly ash used for this research was collected from the thermal power plant, Gandhinagar. Class F fly ash was used as binder material.

Alkali Activator

In this present study sodium silicate and sodium hydroxide were collected from the local supplier to prepare the alkali-activated solution.

3. EXPERIMENTAL INVESTIGATION

3.1. Atterberg's Limit

In Atterberg's limit test, the normal black cotton soil liquid limit, plastic limit, and plasticity index are determined separately and the tests are conducted for a mixed specimen of the black cotton soil with different percentages of Alkali activated fly ash. The liquid limit, plastic limits, and plasticity index of normal soil was obtained 40.31%, 18.78%, and 21.5% respectively. The result of Atterberg's limit is shown in Table 3.1.

From table 3.1, it can be observed that the value of liquid limit was decreased and plastic limit was increased with the amount of alkali activated fly ash was increased and due to that the plasticity index was decreased. Considerable result was obtained when 20% of fly ash with 10% of alkali activator was added in normal black cotton soil. When 30% of fly ash with 10% of alkali activator was added in soil the

plasticity index was increased again. It can be shown in figure 3.1.

3.2. Standard proctor test (SPT)

From the table 3.2, it can be observed that Maximum dry density and optimum moisture content of normal soil was found 1.543 gm/cc and 24.6% respectively and value of maximum dry density was increased and percentage of optimum moisture content was decreased with the percentage amount of fly ash was increased when 20% FA with 10% AA was added in soil and at 30% fly ash with 10% alkali activator the value of maximum dry density was decreased. It can be shown in figure 3.2.1. and 3.2.2.

3.3. Free swell index (FSI)

From the table 3.3, it has been observed that value of free swell index of normal soil was found 33.33. But when the percentage of alkali activated fly ash was added into the soil the value of free swell index was decreased. The considerable result was found at 30% of fly ash with 10% of alkali activator was added in soil.

California bearing ratio test (CBR)

Main objective of this research was increasing the CBR value of black cotton soil by using alkali activated fly ash. CBR value of normal soil was found 0.63%.

From table 3.4, it has been observed that the CBR value was increased when the percentage of alkali activated fly ash was increased and maximum CBR value was obtained when 20% of fly ash with 10% of alkali activator was added in normal soil. At 30% of fly ash with 10% of alkali activator the CBR value was decreased with some amount.

TABLE- 3.1: Atterberg's limit for different specimen

Test specimen	Liquid limit (%)	Plastic limit (%)	Plasticity index (%)
BCS	40.31	18.78	21.52
BCS + 10% FA + 10% AA	36.00	20.00	16.00
BCS + 20% FA+ 10% AA	30.00	20.74	9.26
BCS + 30% FA+ 10% AA	37.90	23.83	14.07

TABLE- 3.2: MDD and OMC of different test specimen

Test specimen	MDD (gm/cc)	OMC (%)
Normal BCS	1.543	24..6
BCS + 10% FA + 10% AA	1.602	21.90
BCS + 20% FA+ 10% AA	1.610	20.70
BCS + 30% FA+ 10% AA	1.574	19.80

TABLE- 3.3: free swell index for different test specimen

Test specimen	Free swell index (%)	Degree of expansiveness
Normal BCS	33.33	High
BCS + 10% FA+ 10% AA	26.52	moderate
BCS + 20% FA+ 10% AA	23.12	Moderate
BCS + 30% FA+ 10% AA	22.29	Moderate

TABLE- 4.1: CBR value for different specimen

Test specimen	CBR value (%)
Normal BCS	0.63
BCS + 10% FA+ 10% AA	2.75
BCS + 20% FA+ 10% AA	3.87
BCS + 30% FA+ 10% AA	3.15

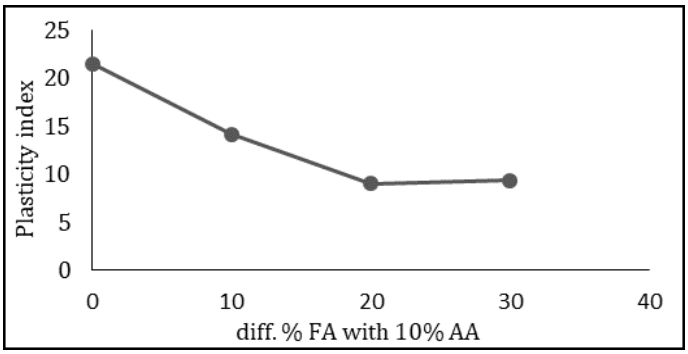

FIG-3.1: PI of BCS with diff % FA with 10% AA

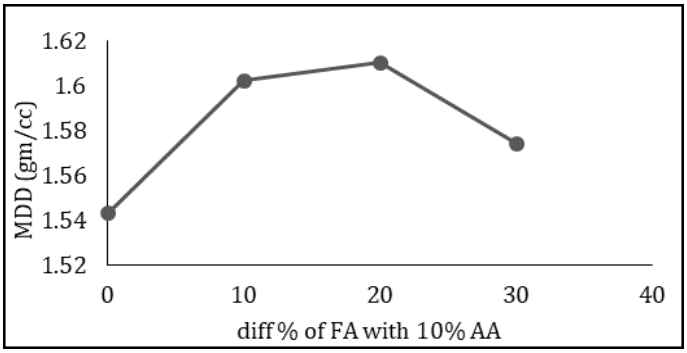

FIG-3.2.1: MDD of BCS with diff. % of FA with 10% AA

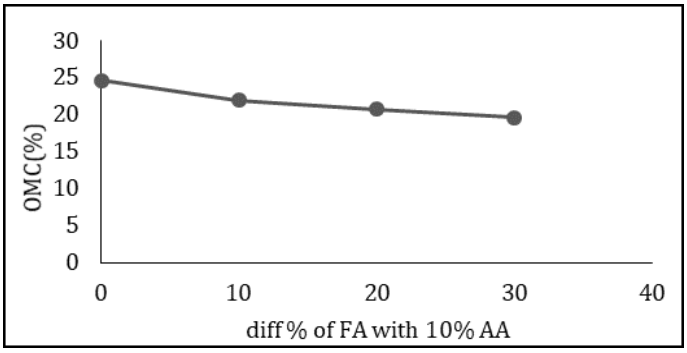

FIG-3.2.1: OMC of BCS with diff. % of FA with 10% AA

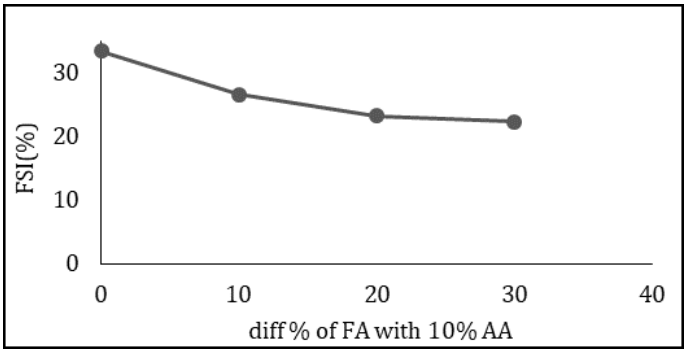

FIG-3.3: FSI of BCS with diff. % of FA with 10% AA

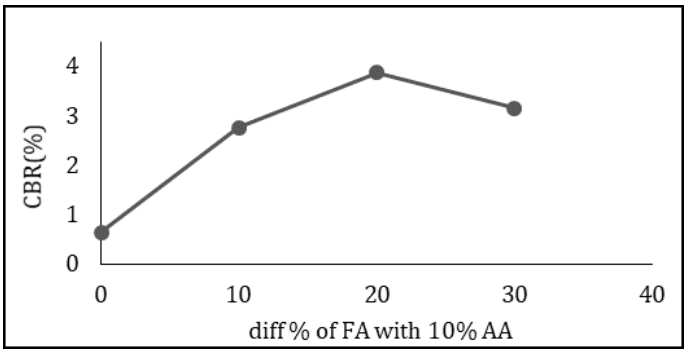

FIG-3.4: CBR value of BCS with diff. % of FA with 10% AA

3. CONCLUSIONS

The following results are obtained after performing the experiments.

- Value of free swell index was decreased from 33.33% to 24.93% at 30% of FA with 10% AA added in normal soil.
- It is observed that the maximum dry density of soil is 1.543gm/cc determined. the value of maximum dry density was increased and optimum moisture content was decreased with the amount of fly ash increased.MDD was increased up to 1.610gm/cc and OMC was decreased up to 19.80%. The considerable best value is obtained at 20% of FA with 10% AA is added in raw soil.
- Value of plasticity index is decreased up to 9.02% at 20% FA with 10% AA added to black cotton soil.
- CBR value is increased from 0.63% to 3.87% at 20% FA with 10% AA.
- Conclusion of the study is that the most of the properties of black cotton soil was improved when 20% of FA with 10% of AA was added in soil.

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