

EFFECT OF GEOPOLYMER ON THE STRENGTH OF BLACK COTTON SOIL

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Abstract

This paper presents in the improvement of problematic soils in a environmental friendly method. The present paper geopolymer to stabilize a soft soil. Geopolymer is an alkali activated solution prepared by combining sodium hydroxide (NaOH) with the sodium silicate solution (Na_2SiO_3). The sodium hydroxide solution is prepared to 12M concentration and $\text{Na}_2\text{SiO}_3/\text{NaOH}$ ratio of 2.5. The geopolymer increases the strength of the black cotton soil by geopolymerisation. The geopolymerisation process involves three separate but interrelated stages. During initial mixing the alkaline solution dissolves silicon and aluminium ions from the amorphous phases of the feedstock. In this solution, neighboring silicon or aluminium hydroxide molecules then undergo a condensation reaction, where adjacent hydroxyl ions from these near neighbors condense to form an oxygen bond linking the molecules and a free molecule of water. The application of mild heat causes these "monomers" and other silicon and aluminium hydroxide molecules to poly-condense or polymerise, to form rigid chains or nets of oxygen bonded tetrahedra. In the present study geopolymer is treated with the black cotton soil. The effect of geopolymer on strength characteristic of Black cotton soil have been studied for a curing period of 7days 15days and 28days. The compressive strength of black cotton soil increases with geopolymer dosage and curing.. The density of black cotton soil also increases with the increase in geopolymer. The test result indicates that geopolymer is very effective in stabilizing the soft soil. An attempt has been made to study the properties of soil treated with geopolymer

Key words : Geopolymer, Black cotton soil, polycondensation reaction.

1. INTRODUCTION

Black cotton soil is considered as a problematic soil due to its swelling and shrinking properties when it comes in contact with water. Due to problem of non availability of suitable soil, so many techniques of stabilization are carried on it. Stabilizing with geopolymer is one among them. Geopolymer is a material formed by condensation reaction. In the present paper, investigations were carried out on the compressive strength of black cotton soil at different geopolymer dosage and curing period of 7, 15, 28 days.

2. MATERIALS USED AND EXPERIMENTAL

STUDY

In the present study black cotton soil is obtained from Kalkeri village Naragunda taluka Gadag District about 100km from Bagalkot, Karnataka state, India. Physical properties of black cotton soil is tabulated in table 1 respectively. Grain size distribution of black cotton soil is as shown in figure 1.

Table 1. Physical Properties of black cotton soil

| | |
|------------------------------------|-------|
| Colour | Black |
| Specific gravity | 2.60 |
| Grain size distribution | |
| Fine sand fraction (%) | 18.0% |
| Silt size (%) | 12.0% |
| Clay size (%) | 70.0% |
| Atterberg's limits | |
| Liquid limit (%) | 76% |
| Plastic limit (%) | 33% |
| Shrinkage limit (%) | 7.5% |
| Compaction characteristics: | |
| Maximum dry density (gm/cc) | 1.34 |
| Optimum moisture content (%) | 33 |

| Combination | Unconfined Compressive Strength (kN/m ²) | | |
|-----------------------|--|-----|-----|
| Curing period in days | 7 | 15 | 28 |
| BCSoil+5% Geopolymer | 216 | 259 | 324 |
| BCSoil+10% Geopolymer | 250 | 273 | 341 |
| BCSoil+15% Geopolymer | 338 | 387 | 398 |
| BCSoil+20% Geopolymer | 362 | 402 | 513 |

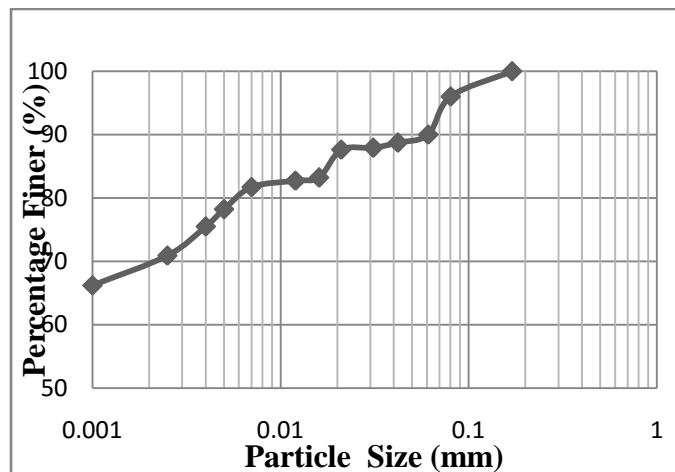


Figure 1. Grain Size Distribution of black cotton soil.

3.RESULTS AND DISCUSSION

Experiments are carried out on untreated B.C. soil and treated B.C. soil with curing period of 7, 15, 28 days. Table 2 shows the addition of geopolymer in percentage.

Table 2. Experimental programme on unconfined compressive strength for black cotton soil and fly ash mixtures

| Mixture | Curing periods in days |
|-------------------|------------------------|
| BC+5% Geopolymer | 7,15 and 28 |
| BC+10% geopolymer | |
| BC+15% geopolymer | |
| BC+20% Geopolymer | |

3.2 Effect of Geopolymer On Black Cotton Soil

The Black cotton soil was mixed with various percentage of Geopolymer and their strength properties have been studied. From the test results as shown in table 3, Black cotton soil alone have compressive strength of 2.13 kg/cm². In addition of geopolymer to Black cotton soil, the compressive strength gets reduces for all dosages of Geopolymer at immediate testing. As the curing period increases compressive strength is also gets increases more than the black cotton soil alone.

Table 3. Unconfined Compressive Strength Of Black Cotton Soil Treated With Various Percentage Of Geopolymer.

From figure 3 to figure 5, graphs are plotted for different percentage dosage of geopolymer cured for 7, 15, 28 days for curing.

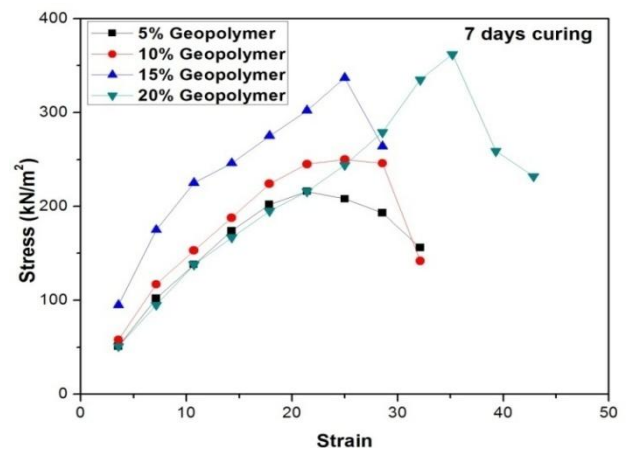


Fig 3. Unconfined compressive strength of black cotton soil treated with various percentage of geopolymer for 7 days of curing.

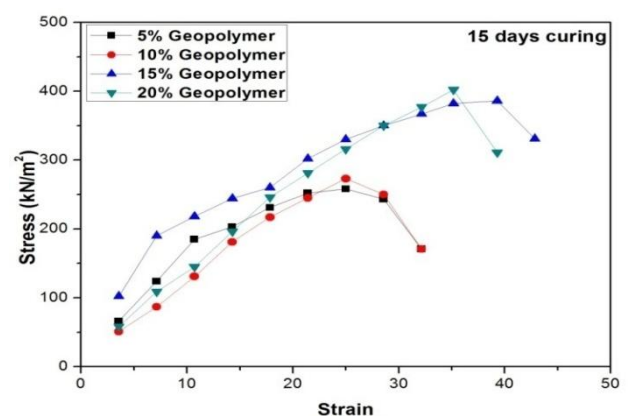


Fig 4. Unconfined compressive strength of black cotton soil treated with various percentage of geopolymer for 15 days of curing.

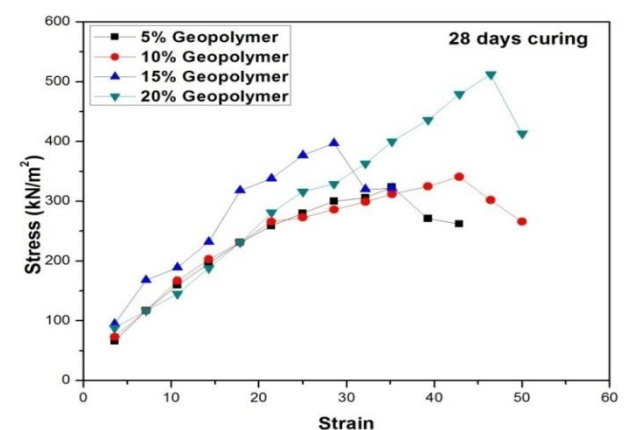


Fig 5. Unconfined compressive strength of black cotton soil treated with various percentage of geopolymer for 28 days of curing.

4. CONCLUSION

The compressive strength increases with the increase in geopolymer. This is because the increases quantity of sodium hydroxide in solution leaches more aluminum and silica from the binder material. Hence this process continues to form a longest rigid network of polymers. So the compressive strength increases with increase in the geopolymer dosage and increase in curing period. From the obtained results we can conclude that, compressive strength of B.C. soil + 20% of geopolymer gives the highest strength for 28days of curing period as compare to different dosages and for different curing days.

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