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STABILIZATION OF GGBS TREATED BC SOIL USING IRON POWDER

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Abstract - Soil stabilization is a technique introduced many years ago with the main purpose of improving the soil capacity of meeting the requirement of engineering projects. The soil stabilization techniques are used to improve the geotechnical properties of soil by adding the material such as lime, cement, geo polymer, industrial by products such as fly ash, GGBS, pond ash, slag etc. Black cotton soil covers 1/5th of the area of our country owing to its undesirable engineering properties such as high swelling – shrinkage, and poor shear strength, the soil is not good either as foundation or embankment material. In the present work an attempt is made to improve the engineering properties of black cotton soil by adding GGBS and Iron powder. The proportion of GGBS used in the present study are 0,2,4,6% by weight of the soil and the proportion of iron powder used are 0,2,4,6,8,10% by the weight of the soil. The various geotechnical aspects focused in the present study are index properties, compaction characteristics, strength characteristics, Comparisons of the above two admixtures are done on the basis of test results obtained.

***Key Words*: Soil stabilization, Geotechnical, Index properties, GGBS, Compaction characteristics.**

1. INTRODUCTION

The Black Cotton Soils cover about 20% of land area in India and are predominantly located in the Deccan trap covering the states of Maharashtra, Gujarat, Madhya Pradesh, Karnataka, Andhra Pradesh, Tamil Nadu, Uttar Pradesh and Rajasthan. It is also called as Regur or black soil. Most Indian Black Cotton soils are rich in Montmorillonite, a type of clay mineral. This mineral is responsible for swell-shrink behavior of the soil. Hence it is interesting to study the disparity in the behavior of Black Cotton soil containing Montmorillonite with respect to Black Cotton soil containing interstratified mineral. Black cotton soil is produced geologically by the disintegration of volcanic rock and is very rich loamy earth of great fertility and unusually power of retaining moisture. The soil varies in color from grey to deep black. In the beginning it was considered that black color was due to the presence of humidified organic matter. Subsequent work has however, shown that the color is due to small concentration of titanium oxide. Black cotton soils exhibit high swelling and shrinkage when exposed to changes in moisture content and hence have been found to be most troublesome from engineering considerations. One day they are dry and hard, and the next day wet and soft. Swelling soil always create problems for lightly loaded structure, by consolidating under load and by changing volumetrically along with seasonal moisture variation, resulting in damage to foundation systems, structural elements and architectural features. In a significant number of cases the structure becomes unstable or uninhabitable the Stabilization occurs when iron powder and GGBS is added to black cotton soil and a pozzolanic reaction takes place.

1.1 Objectives

The main objectives of the present work are as follows

1. To determine the index properties of black cotton soil and stabilized black cotton soil treated with GGBS and Iron powder.
2. To determine the compaction characteristics of soil and stabilized black cotton soil treated with GGBS and Iron powder.
3. To evaluate strength characteristics of soil and stabilized black cotton soil treated with GGBS and Iron powder by conducting series of unconfined compression test. And also to study the effect of curing on the unconfined compressive strength of stabilized soil.

2. LITERATURE REVIEW

Phanikumar and Sharma et. Al,(2004),Studied the effect of fly ash on engineering properties of expansive soil through an experimental programme. 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 fly ash contents of 0, 5, 10,15 and 20% on a dry weight basis and they inferred that increase in fly ash content reduces plasticity characteristics and the FSI was reduced by about 50% by the addition of 20% fly ash.

Sabat et. Al.(2005),Carried out the stabilization of expansive soil using fly ash-marble powder mixture. He concluded that the optimum proportions of soil, fly ash, and marble powder in the mixture in percentage by weight to give the best result were 65%, 20% and 15% respectively.

Rajesh et.Al. (2006),Discussed about an experimental investigation of clay beds stabilized with fly ash-lime segments and fly ash segments. An observation of swelling in clay beds of 100 mm thickness strengthened with 30 mm diameter fly ash-lime and fly ash segments. There was a considerable decrease in heave in both fly ash-lime and fly ash columns. However, lime-fly ash mixture generated better results.

Manjunath et.Al., (2012),Carried out research on the influence of GGBS and lime on the unconfined compressive strength properties of black cotton soil. Lime and GGBS were added in various combination with curing of 0, 7 & 28 days. The results showed that soil stabilised with GGBS and lime gave strength higher than that with lime only. The optimum mixture identified that with 30% GGBS and 4% lime, the strength was 18 times more than the black cotton soil alone after 28 days curing

Rajesh et. Al. (2017),States that -The lowest dry density was observed to be about 1.84g/cc for 90% soil and 10% GBFS mixture and maximum density was about 2.05 g/cc for 50% soil and 50% GBFS mixture. The lowest CBR value was observed to be about 3.26% for 90% soil and 10% GBFS mixture and maximum CBR value was about 8.74% for 50% soil and 50% GBFS mixture.

Ashutosh et.Al. (2016),Stated that using GGBS as stabilizer gives the following advantages cost savings, availability, waste management. It was also observed that with increase of slag, more stability of soil is achieved as compared to using lime alone.

Mukul et.Al. (2017),Suggests that from UCS test results the addition of GGBS up to 40%, it increases the strength of the test specimen. However, after 30% there is very little increase in UCS strength. The UCS strength increased from 230.1KPa for 100% black cotton soil (0% GGBS) to 443.3 for 70% black cotton soil (30%GGBS). Therefore, they have concluded that 30% is the optimum dosage of GGBS in soil.

3. MATERIALS

BLACK COTTON SOIL

For the present study it is proposed to collect the required black cotton soil from Kalaghatagi at a depth of 2.5 metre below the ground level. The obtained soil is air dried and pulverized manually and sieved through 425 µ IS sieve, except for sieve analysis.

GGBS

For the proposed study, the required GGBS is planned to collect from Hubli.

IRON POWDER

For the present study, the iron powder is planned to collect from Hubli.

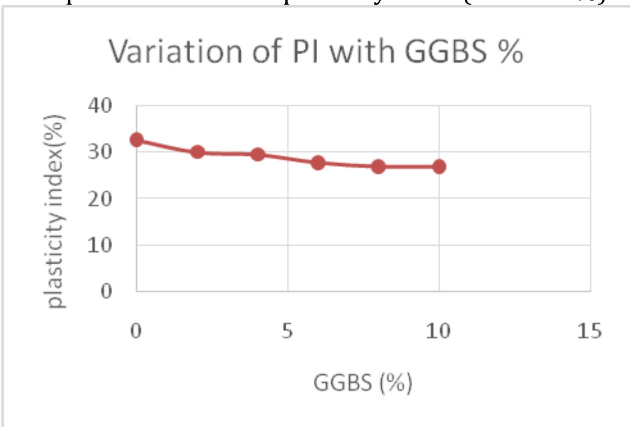
4. METHODOLOGY

Grain size analysis
Atterberg's Limit
Mini Compaction Test
Unconfined Compression Test
Free Swell Index

5. RESULTS AND DISSCUSSION

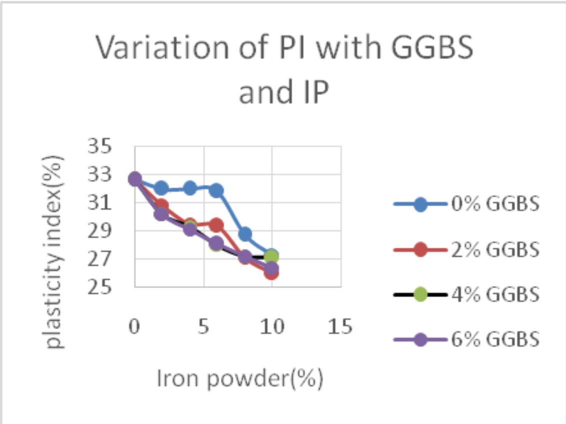
5.1 ATTERBERG'S LIMIT (CONSISTENCY LIMITS)

Table shows the values of the Atterberg's limits and plasticity index obtained for various percentages of GGBS added by weight of the BC soil treated with iron powder. Untreated BC soil exhibits plasticity index of 32.63%. From the table 5, it is observed that addition of 10% GGBS to the BC soil produced the least plasticity index (i.e. 26.88%).



%GGBS by weight of soil	LL(%)	PL (%)	PI (%)
0%	79.25	46.62	32.63
2%	79.22	49.23	29.98
4%	76.71	47.22	29.49
6%	72.19	44.44	27.74
8%	68.56	41.66	26.89
10%	65.77	38.88	26.88

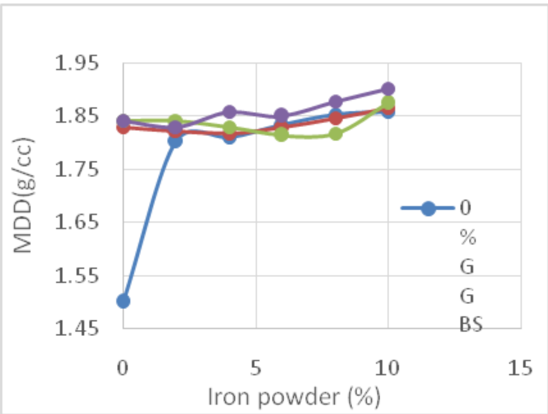
Table shows the values of the Atterberg's limits and plasticity index obtained for various percentages of GGBS and iron powder added by weight of the BC soil. Untreated BC soil exhibits plasticity index of 32.63%. From the Table6 it is observed that addition of 2% GGBS+10% IP to the BC soil gives least plasticity index (i.e. 26.07%).The reduction in the Plasticity Index values are mainly attributed to the depression of double layer thickness due to readiness of cation exchange.



5.2 COMPACTION TEST

Compaction of BC Soil mixed with GGBS and Iron powder (IP)

The results of dry density as a function of GGBS with IP-soil mixture and moisture contents are shown in Fig8. Table 8 summarizes the OMC and MDD values. BC soil has the lowest MDD (1.49g/cc) at the highest OMC(28%.). From the table 8 it is observed that addition of 6% GGBS+10% IP to the BC soil gives higher values of MDD (i. e. 1.902g/cc).This may be explained due to the formation of Silicacious material and cation exchange reaction. This is attributed to the factor that the C_3A present in GGBS reacts with the water, lowering the overall moisture content of the soil.

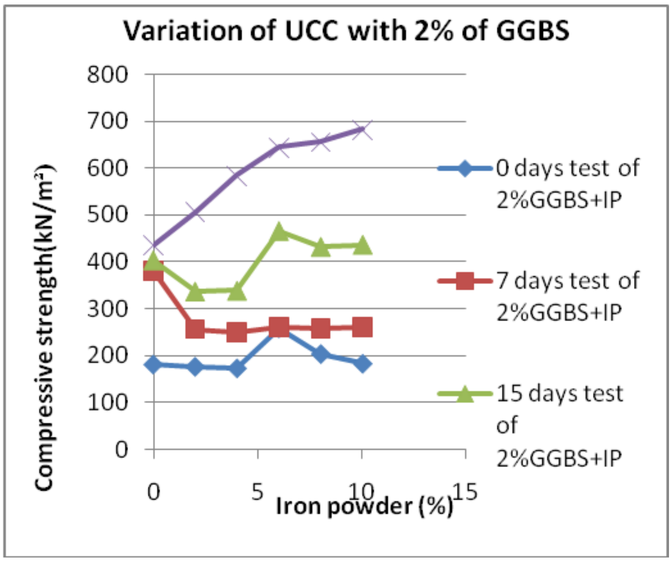


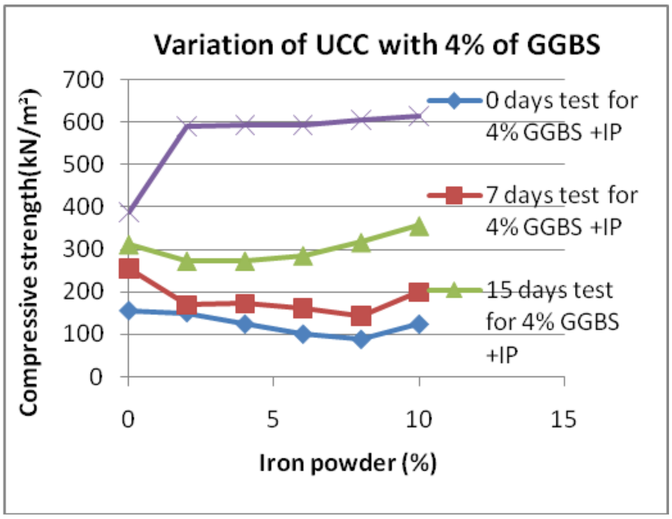
5.3 UNCONFINED COMPRESSION TEST

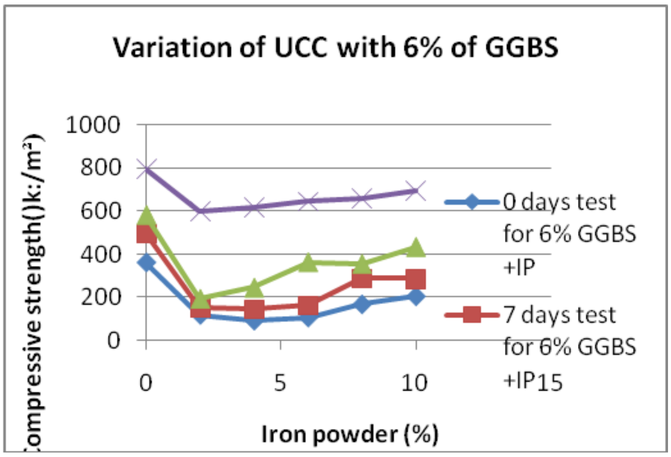
BC soil alone got UC Strength of about 63.205 kN/m^2. Addition of 6% GGBS to the BC soil after curing 30 days exhibits the UC Strength of 796.690kN/m^2.

Unconfined Compressive Strength forGGBS and Iron powder (IP)

Also the addition of 6% of GGBS and iron powder to the BC soil after curing of 30 days exhibits higher UC Strength of 693.216 kN/m^2 compared to all other combination.

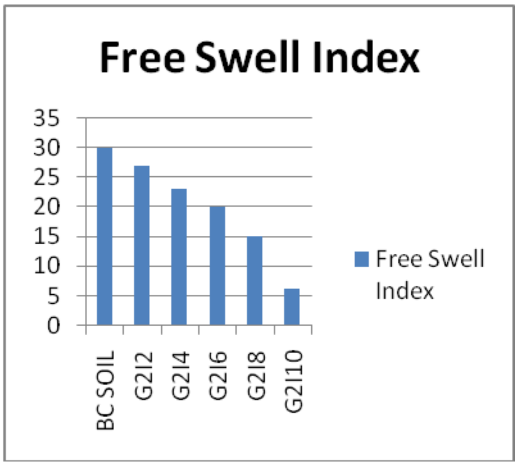


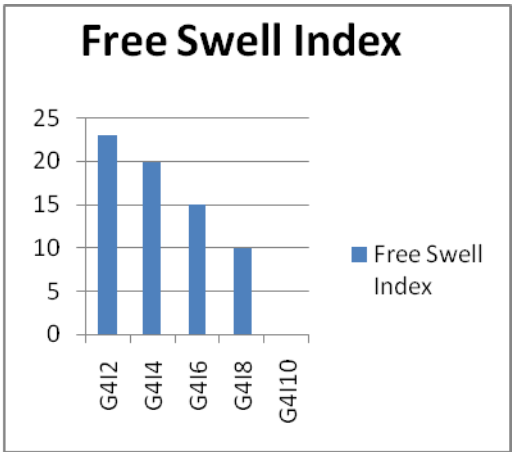


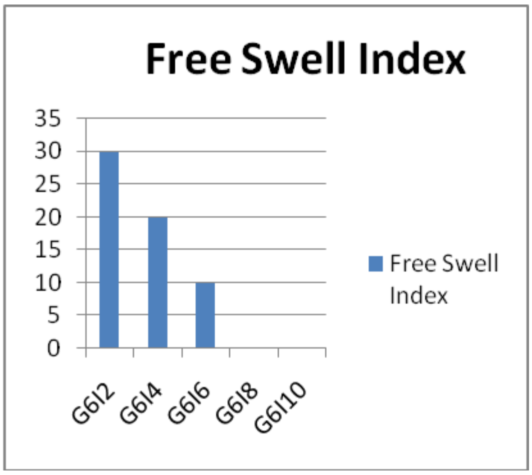


5.4 FREE SWELLING INDEX

The free swelling index of soil is found to decrease with increase in GGBS and iron powder percentage. For the present study we found zero swelling at 4% GGBS with 10% Iron Powder and 6% GGBS with 8% and 10% Iron Powder.







6. CONCLUSIONS

The following conclusions are drawn from the present investigation,

1) BC soil pocesses LL of 79.27% but addition of GGBS and IP reduces the LL of BC soil indicating the reduction in volume change behavior of BC soil.

2) BC soil treated with GGBS and IP achieved MDD at lowest OMC

3) Increased percent of GGBS and IP in the BC soil enhances the strength of BC soil mixed with the increased curing periods.

4) AS the percentage of GGBs and IP in the BC soil increases the free swelling index decreases..

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