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Unconfined Compressive Characteristics Strength of Alkali Resistant Glass Fiber with Black Cotton Soil Blended with Lime

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Abstract

Geomechanical properties of Black Cotton Soil are known by conducting a laboratory study of Lime and Alkali Resistant Glass Fiber (ARGF) when it is blended with black cotton soil. The utmost importance is to find the properties of the compaction characteristics of black cotton soil. The subsequent phase pivots on the Unconfined Compressive Strength values of a mixture of Black Cotton Soil with optimum content with the unreliable percentage of lime and ARGF. This study pivots on change in Unconfined Compressive Strength with curing period. The Unconfined Compressive Strength values are inflated with the inclusion of lime and ARGF BC soil. The unconfined compressive strength values are inflated with the curing period. Finally, the UCS values for different combinations like BC soil alone, BC soil and randomly distributed fiber like ARGF.

Keywords*: - Black cotton soil, lime, alkali resistant glass fiber, compaction characteristics, shear characteristics, granular stabilization, natural fibers, synthetic fibers, Plastic limit, and liquid limit.*

INTRODUCTION

The extending estimation of territory and the limited availability of land for advancement lead to the improvement of distinctive structures. The stability of any structure relies on the properties of the soil

on which it is to be built. In case if the earth has poor bearing capacity at shallow underneath the ground surface, then major foundation problems exist. This problem can overcome by using stacks, wells and caissons. Significant foundations are exorbitant and financially impractical, and uneconomical.

Geotechnical engineers face issues while sketching out the foundations on compressible clayey soil. Most of the naturally occurring soils are having good compressive quality, shear strength but are fragile in strain/poor unbending nature. To vanquish the same, various examiners have centered their studies on soil change techniques by elaborating the composite materials. Enhancement of certain needed properties of soil like compaction, CBR, unconfined strength, shear quality, Swelling properties can be grasped by a combination of soil improvement strategies. There are various techniques to study. Each one of these techniques requires talented work and equipment to ensure palatable execution. Expansive soil is the fundamental cause of damages to several structures like highways, airport runways, spread footings, buildings and earth dams constructed over expansive soil. Black Cotton soil is one of the soils which is having high compressibility. A lesser amount of stability, low shear strength and large extension and contraction in volume with respect to weather are the main problems faced with the Black Cotton soil. Almost 23% of the area in India is covered by Black Cotton soil. BC soil contains mainly Montmorillonite clay which absorbs the water, hence dramatic changes in the volume of the soil, which leads to damages to the structure.

NEED FOR THE PRESENT WORK

The present work is conceded out to find the shear characteristics of soil blended with an optimum percentage of lime with dissimilar percentages of synthetic fiber (ARGF). In initial optimum dosage of lime was found by compaction. The unconfined compression strength test is conducted for Black Cotton Soil with an optimum dosage of lime with varying percentages of ARGF fiber.

OBJECTIVES

In present work has been taken for knowing the following

1. To determine the optimum percentage of lime.

2. To determine the shear strength characteristics of fibers with black cotton soil.

3. To know the amount of lime and Alkali Resistant Glass Fiber required to obtain maximum strength industrial waste products and by making use of naturally available natural fibers and synthetic fibers.

EXPERIMENTAL INVESTIGATION

Table 1: Geotechnical properties of BC soil

Specific Gravity	2.51
Liquid Limit (%)	54
Plastic Limit (%)	22.75
Plasticity Index (%)	31.25
Shrinkage Limit (%)	12.37
Silt and Clay Content (%)	76
Maximum Dry Density (KN/m^3)	13.09
Optimum Moisture Content (%)	22

UNCONFINED COMPRESSIVE STRENGTH OF BLACK COTTON SOIL

To determine the confined compressive strength of BC soil. The unconfined compressive strength (q_u) is the load per unit area at which the cylindrical specimen of a cohesive soil falls in compression.

Table 2: Details of UCS specimen preparation chart for ARGF includes in BC soil blended with lime

S. no	SOIL (gm)	LIME (gm)	ARGF %	ARGF (gm)	WATER (ml)
1	139	--	--	--	16
2	118	21	0.25	0.295	16
3	118	21	0.5	0.59	16
4	118	21	0.75	0.885	16
5	139	21	1	1.18	16
6	139	--	--	--	16
7	139	--	--	--	16

RESULTS AND DISCUSSION

1. Unconfined Compressive Strength of BC soil for various curing Period

The different specimens of Black cotton soil alone are prepared at obtained OMC and are tested in UCS test apparatus for different curing days of 0, 7, 14, and 28. The table below shows the variation in UCC strength of BC soil with the curing period.

Table 3: Variation of UCC Strength of BC soil With Curing Period

Number of Curing days	0	7	14	28
UCC Strength KN/m^2	124.149	125.828	127.289	131.997

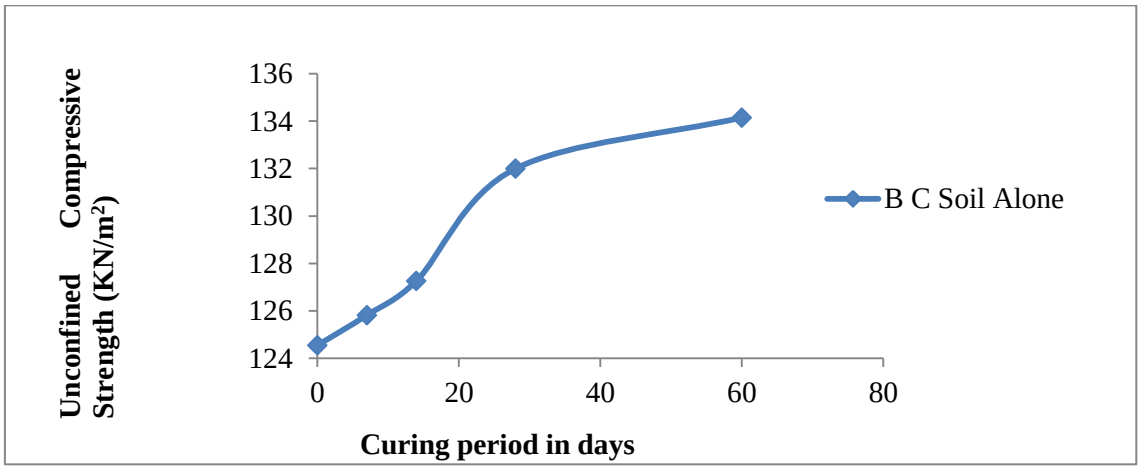

Figure 1: Variation UCC Strength of BC Soil for Various Curing Period

In the above figure, it is observed that the UCS of BC soil alone has been increased slightly with the increased curing periods like 7, 14, 28 days.

2. Compaction characteristics of black cotton soil mixed with lime

The tests are carried out on compaction of black cotton soil with varying percentages of ARGF to obtain the optimum dosage of LIME, which can be used for further experimental study. Fig below shows the typical compaction curves obtained for BC soil treated with different percentages of lime. From figure 2, it is observed that MDD and OMC are obtained by adding 3% of lime to the black cotton soil in the present experimental study. Hence it can be concluded that 3% of lime is optimum for BC soil used in this experimental study.

Table 4: Compaction characteristics of BC soil with various percentages of lime

Mix designation	MDD (KN/ m^3)	OMC
BC soil alone	13.09	22
BC soil + 1% of lime	14.32	20
BC soil + 2% of lime	15.11	18
BC soil + 3% of lime	15.79	18
BC soil + 4% of lime	13.83	16

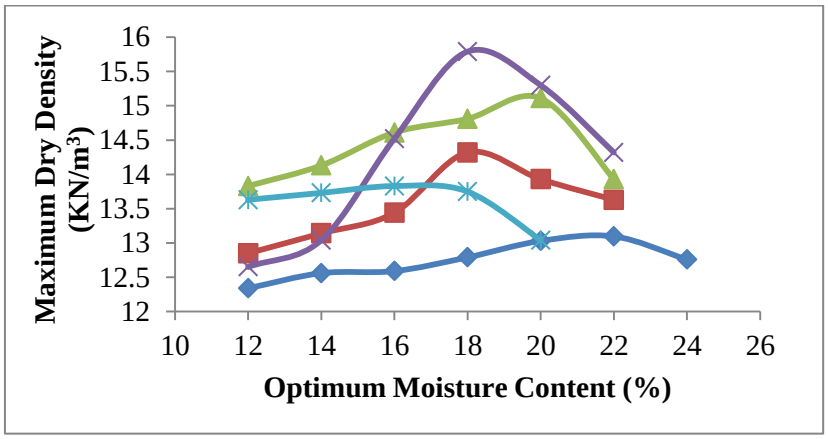

Figure 2: Compaction characteristics of BC soil with various percentages of lime

The Maximum Dry Density (MDD) and Optimum Moisture Content (OMC) values are changing, as the addition of lime from 1%, 2%, 3%, 4% to Black Cotton soil the Dry density has improved significantly, and the optimum moisture content decreased. After that, with the addition of more %, there was no further increase in MDD and the optimum moisture content. The max value of MDD is 15.79, and OMC is 22 are achieved on the addition of 4% to the BC soil.

3. Unconfined compressive strength test results

a) Unconfined Compressive Strength of BC soil + 3% lime for various curing Period

Table 5: Variation of UCC Strength of BC soil with 3% lime for Various Curing Periods

Number of curing days	0	7	14	28
UCC strength in KN/m^2	181.48	254.07	303.12	349.23

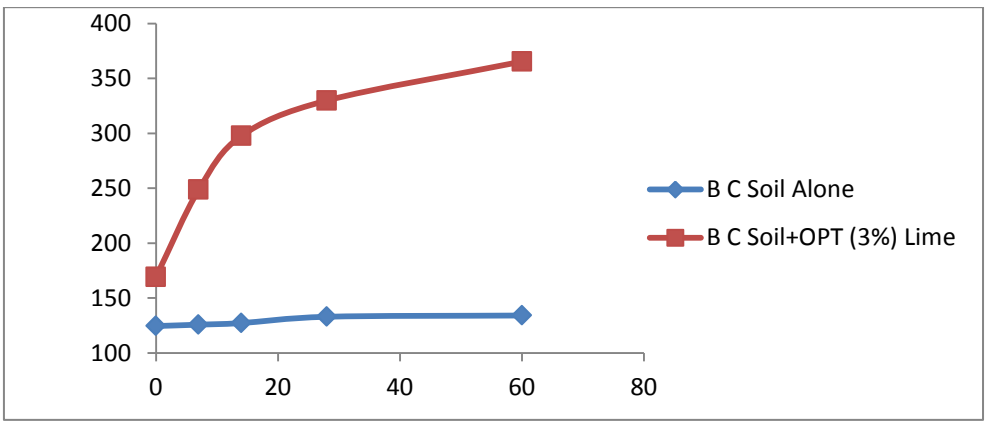

Figure 3: BC soil with 3% lime for various curing 28 days

It has been observed from the values obtained from the UCS test and from figure 3, it is clear that the unconfined compressive strength has been increased rapidly up to 14 days; later, it is observed the strength is increased gradually up to 60 days.

b) Unconfined Compressive Strength of BC soil +3% of lime for various curing Period

Table 6: Variation of UCC Strength of BC soil with 3% of lime for Various Curing Periods

Number of curing days	0	7	14	28
UCC strength in KN/m^2	169.26	248.701	297.713	329.9

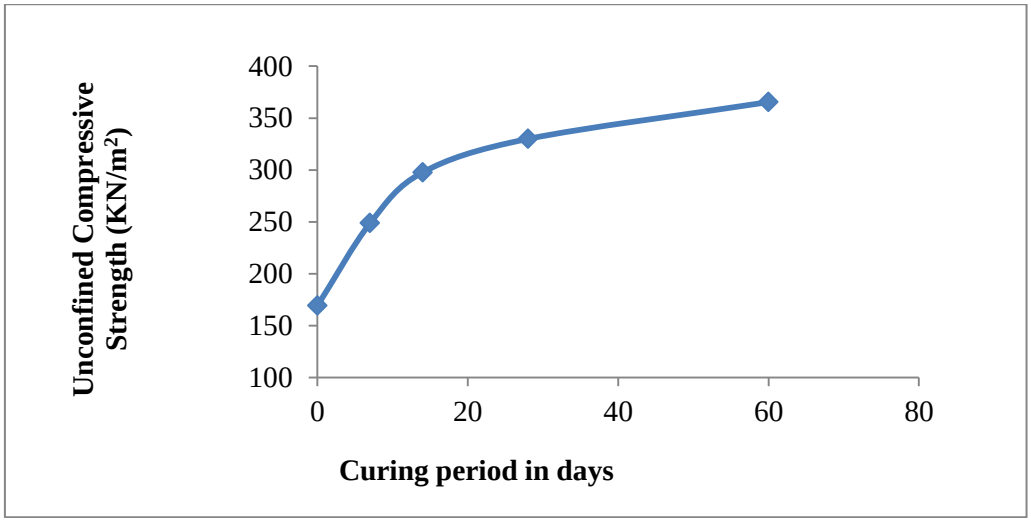

Figure 4: Variation of UCC Strength of BC soil with 3% of lime for Various Curing Periods

From the above figure 4, it is clearly seen that the unconfined compressive strength of BC soil is 297.713 with the curing period, and maximum unconfined compressive strength is obtained 28 days.

c) Unconfined Compressive Strength of BC soil with various percentage of ARGF for Various Curing Periods.

Table 7: Variation of UCS for BC soil with various percentages of ARGF fibers

No. of days ⟶	**0**	**7**	**14**	**28**	**60**
BC soil + 0.25% ARGF	294.372	309.794	329.019	347.352	355.285
BC soil + 0.5% ARGF	306.924	315.866	339.276	361.221	378.072
BC soil + 0.75% ARGF	317.27	324.265	346.983	389.5	423.382
BC soil + 1.0% ARGF	308.948	320.731	337.415	373.952	392.451

The specimen having 0.75% ARGF fibers gives the best UCS for all curing days.

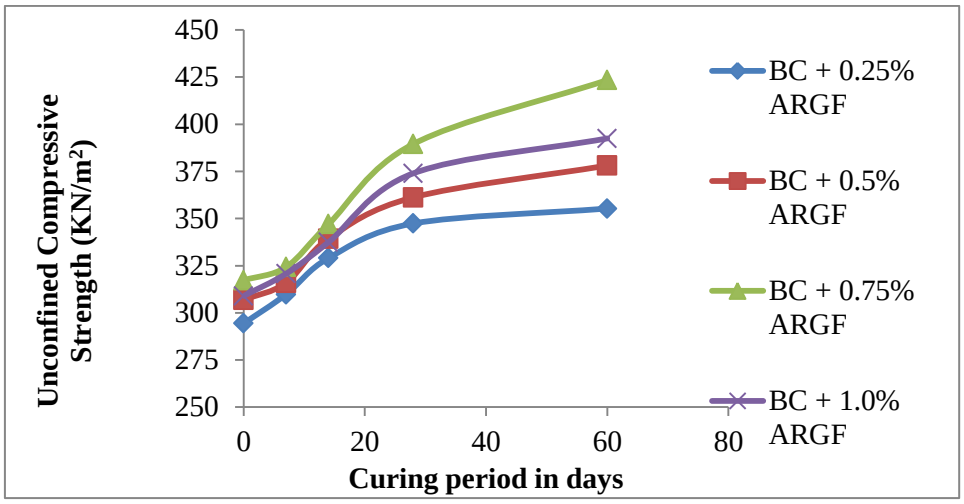

Figure 5: Variation of UCS for BC soil with various percentages of ARGF fibers

d) Unconfined Compressive Strength of BC soil with various percentage of ARGF for Various Curing Periods.

Table 8: Variation of UCS for BC soil blended with 3% of lime for various percentages of ARGF

No. of days ⟶	0	7	14	28
BC soil + 0.25% ARGF	321.716	370.017	408.853	442.723
BC soil + 0.5% ARGF	343.78	388.033	435.614	484.211
BC soil + 0.75% ARGF	373.26	421.817	493.93	547.23
BC soil + 1.0% ARGF	358.81	386.162	450.26	497.67

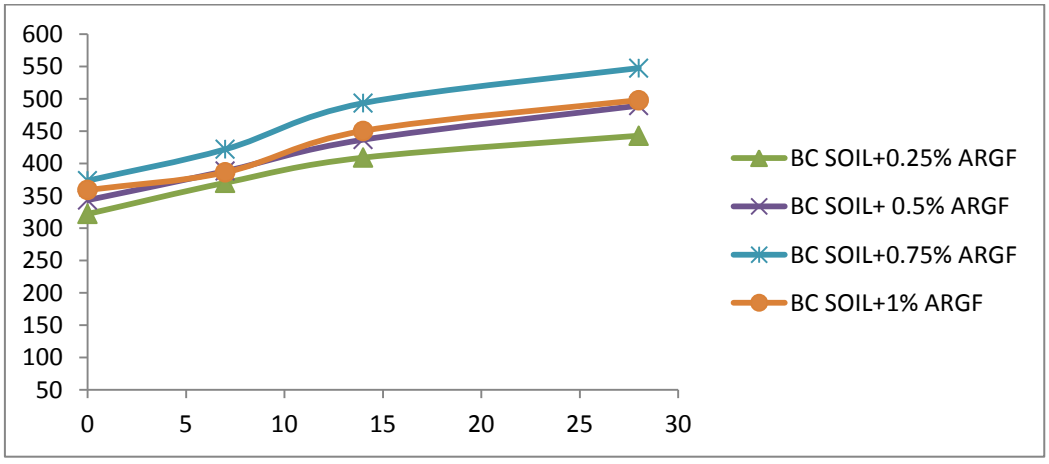

Figure 6: Variation of UCS for BC soil blended with 3% of lime for various percentages of ARGF

From the above Figure 6, it can be observed that with the increase in the content of ARGF Fiber, the compressive Strength also got increased. The specimen containing 0.75% ARGF fibers gives maximum compressive strength values for different curing days.

e) Comparison of UCS of BC Soil Alone and BC Soil + 3% of lime

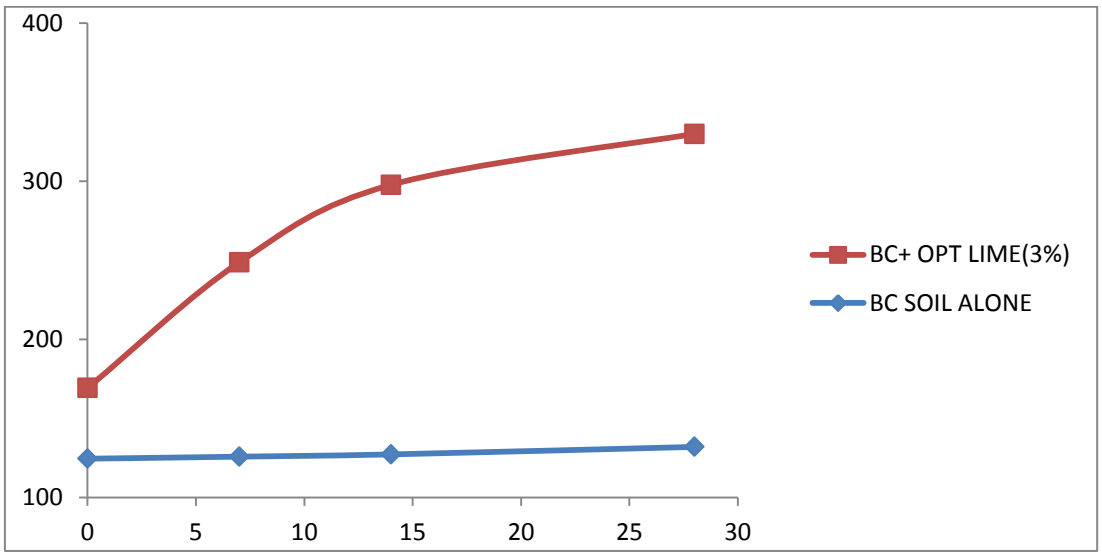

Figure 7: Comparison of UCS of BC Soil Alone and BC Soil + 3% of lime

f) Comparison of UCS of BC Soil Alone, BC Soil + 3% of opt lime and BC soil + 3% of opt lime + 0.75 % of ARGF

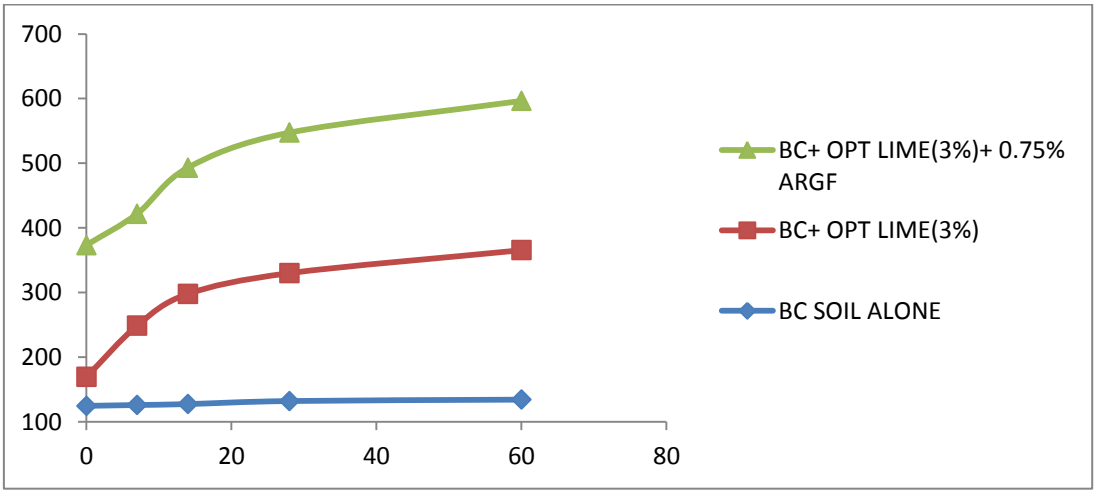

Figure 8: Comparison of UCS of BC Soil alone, BC Soil + 3% of opt lime and BC soil + 3% of opt lime + 0.75 % of ARGF

From the above Figure 8, it can be observed upon the addition of fibers, the strength of BC soil increased drastically. As we can observe, the UCS strength of sample containing BC soil and 0.75% SF decreases after curing of 28 days; this may be due to biodegradation of Sisal Fiber. Whereas the UCS of a sample containing BC soil and 0.75% ARGF does not decrease because of its non-biodegradable property.

g) Comparison of UCS of BC soil alone, BC soil + 3 % of lime, BC soil 0.75% ARGF, BC soil + 3% lime + 0.75% ARGF

From the below figure, it can be observed upon the addition of fibers, the strength of BC soil increased drastically. As we can observe, the UCS strength of a sample containing BC soil and 0.75% SF decreases after curing of 28 days; this may be due to the biodegradation of Sisal Fiber. Whereas the UCS of a sample containing BC soil and 0.75% ARGF does not decrease because of its non-biodegradable property.

From the below Figure 9, it can be observed that with the increase in the content of ARGF, the compressive strength also got increased. For all different curing days, the maximum Compressive Strength is obtained for the mixture of 0.75% fiber. From figure 9, it can be observed that the compressive strength increases up to fiber content of 0.75% beyond which starts decreasing for all different curing days. The specimen containing 0.75% ARGF fiber gives maximum compressive Strength values for different curing days.

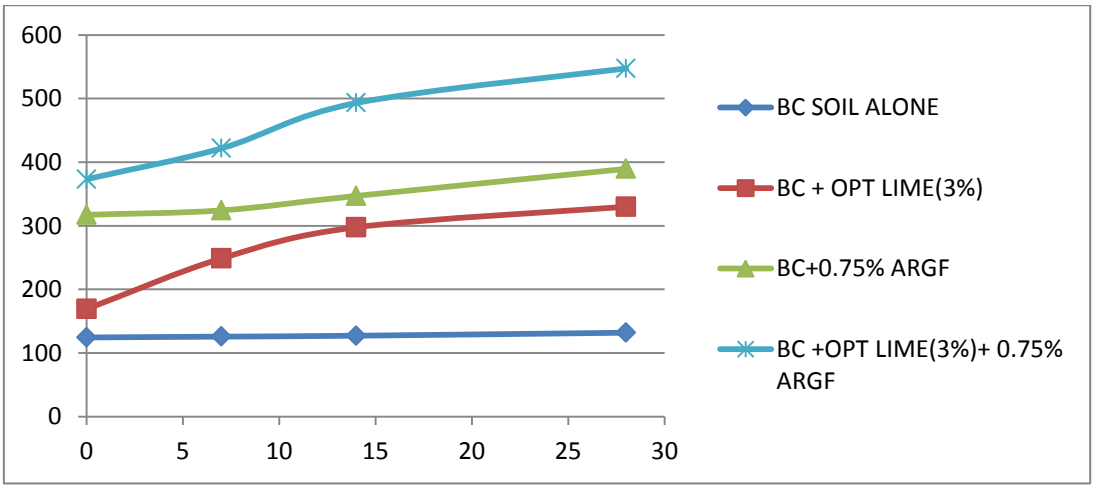

Figure 9: Comparison of UCS of BC soil alone, BC soil + 3 % of lime, BC soil 0.75% ARGF, BC soil + 3% lime + 0.75% ARGF

CONCLUSIONS

1. Unconfined Compression Strength is carried out on a varying percentage of alkali-resistant glass fiber blended with an optimum dosage of lime.

2. Lime is a by-product of the manufacturing industry which is proved to be economical, good stabilizing material and rich in silica.

3. The density of BC soil increased from 13.09 KN/m^3 to 15.79KN/m^3 by the addition of lime. Maximum Dry Density is found to be 15.79 KN/m^3 with Optimum Moisture Content of 16%.

4. From the moisture density relationship, the optimum lime content is discovered to be 16%, as Dry Unit Weight is maximum matching to lime when compared to other percentages of lime.

5. The unconfined compression strength of black cotton soil 134.15KN/m^2, which is increased to 541.253 KN/m^2 upon addition of 3% 0f lime and 0.75% ARGF fiber for a curing period of 28 days.

6. Addition of 0.75% ARGF with BC soil blended with 3% of lime, the UCS increased from 134.15 KN/m^2 to 596.381 KN/m^2 for 28 days curing.

7. The UCS of the specimen having 0.75% ARGF fiber only increased from 308.183 KN/m^2 to 366.252 KN/m^2 for 28days curing, beyond which strength reduces. The UCS of specimens containing 0.75% ARGF increased from 317.270 KN/m^2 to 423.382 KN/m^2.

8. The curing period increased the UCS of specimens having lime and ARGF; the increment in strength was found to be from 324.058 KN/m^2 to 465.253 KN/m^2 for a specimen having Opt lime and 0.75% ARGF for 28 days curing.

9. The UCS of specimens containing 3% of lime and 0.75% ARGF has increased with curing, which increased from 373.261 KN/m^2 to 596.381 KN/m^2 for 28 days curing.

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