

Improvement of Black Cotton Soil with Cement & Flyash Treated With Terrasil

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ABSTRACT

BC soils or expansive clays soils associated with so many problems as volume shrinkage, expansively, low CBR, swelling etc. Fly ash is freely available as it is waste product obtained from power plants, it is less hazardous to environment and as a good stabilizer material, and fly ash counteracts the problem of pollution. Flyash. Mixed with cement and commercially available chemical terrasil, shows improved results for the geotechnical properties of black cotton soil associated with cement, flyash mix treated with terrasil. Pavement design on BC soil in which cost reduced to 16.25% when treated with BC soil fly ash, cement, treated with terrasil.

Keywords : Black Cotton Soil, Fly Ash, Cement, Terrasil.

I. INTRODUCTION

Black cotton soils are commonly found in various part of world including India. Black cotton soil is clayey soil. Its colour is black to grayesh. They are highly expansive characteristics due to present of montmorillonite clay mineral. It has high moisture content, having low shrinkage limit & high optimum moisture content. There is considerable damage to build up property mainly because of differential settlement of the dried-up black cotton soil. Climatic and environmental changes are the main cause for the swelling and shrinkage of these soils. Local man-made conditions also cause changes in moisture content and volume of the soil mass. The shear strength of soil is very high in dry state and it reduces in wet state. The design of foundations and pavements founded on swelling soils always involve a certain degree of risk and damage. Usually even the lowest cost of the design alternative will be associated with high degree of risk. Hence, the properties of the soil may be improved to make the soil suitable for construction purposes. There are several techniques available to improve the soil properties. Chemical stabilization is one among them. Even though it is more expensive than other types of stabilization methods, it is preferred because setting and curing times can be controlled.

Fly ash is obtaining from thermal power plants, steel industries, paper mills etc. it is freely available and also having less compendious value due to which it act as a pozzalanic material, it is non-plastic material and hence it is good stabilizer material as it reduces the pollutant in certain amount, it increases the geotechnical properties of soil when reacting with soil. In present study class-f fly ash was chosen which is suitable for fine grained soil. To increase the properties of soil, adding cement opc 43 grade along with fly ash increase the properties of BC soil. But as economical less amount of cement is used in our project.

In the present study black cotton soil was chemically stabilized by using a commercially available chemical named Terrasil along with fly ash and cement mixture. The objective for study was to determine geotechnical properties of virgin and treated black cotton soil, and to evaluate the cost of construction per kilometer.

II. METHODS AND MATERIAL

Black Cotton Soil

The investigation was carried out on samples black cotton soil which is grayish in color with high moisture content. The various properties of the soil obtained given in Table 1

Table 1 : Properties of BC soil

Sr. No.	Laboratory	Test Result
1	Grain Size Distribution	Gravel = 3.17% Sand = 12.80% Silt = 0.20% Clay = 83.83%
2	Specific Gravity (G)	2.52
3	Classification of soil	CH
4	Liquid Limit (WL)	60.50%
5	Plastic Limit (WP)	31.0%
6	Plasticity Index (IP or P.I)	29.5%
7	Free Swell Index (F.S.I)	45%
8	Optimum Moisture Content (O.M.C.)	18%
9	Maximum Dry Density (M.D.D.)	1.60g/cc
10	California Bearing Ratio (C.B.R.)	1.48%

Terrasil

Terrasil is a chemical stabilizer which is available commercially. It improves geotechnical properties like, increase in CBR, reduces permeability and free swell, expansion. BC soil with fly ash mixed with cement and treated with terrasil gives improved results.

Properties of Fly ash & Cement

Class F fly ash & Cement properties are given in Table 2.

Table 2 : Properties of Fly ash & Cement

Constituent	% by mass Fly ash	% by mass Cement
SiO ₂	55%	20%
Al ₂ O ₃	20.3%	6.3%
Fe ₂ O ₃	6.3%	3.3%
SO ₃	1.5%	1.5%
CaO	12.0%	63%
MgO	3.5%	2.4%
Alkali	1.0%	1.0%

Preparation of Samples

Samples were prepared using the combination of BC soil fly ash cement with Terrasil. The percentage of Fly ash was taken as 5%, 10%, 15% with Terrasil & Percentage of Cement as 0.5%, 1.0%, 1.5%. With Terrasil various combination of fly ash cement and terrasil have been chosen for preparation of samples various test performed on various combination

1. Atterbergs limit
2. MDD, OMC CBR
3. Permeability test
4. Free swell index

The test result of various combination are given in Table 3

Table 3. Test results of various combination of BC soil, cement, with Terrasil

COMBINATIONS	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX	MDD(gm /cc)	OMC(%)	CBR(%)	FSI (%)	shrinkage limit(%)
BC-VIRGIN	60.5	30.95	29.55	1.6	18	1.48	45	9.15
BC+T	58.1	29.75	28.35	1.64	18	3.39	40	10.9
BC+FA5+T	56.5	29	27.5	1.67	17	2.43	55	15.5

BC+FA10+T	53.8	27.85	25.95	1.69	17	3.39	45	17.5
BC+FA15+T	52.7	27.45	25.25	1.7	18	9.38	44	19.3
BC+C0.5+T	58	28.9	29.1	1.69	21	3.65	66	14.6
BC+C1.0+T	56.7	27.9	28.8	1.7	21	8.68	60	20.4
BC+C1.5+T	56.2	27.55	28.65	1.71	22	9.38	60	22.3
BC+C0.5+FA5+T	54.2	27.55	26.65	1.69	17	4.51	50	17.7
BC+C0.5+FA10+T	53.3	27.1	26.2	1.68	18	10.33	30	18.55
BC+C0.5+FA15+T	52.1	26.65	25.45	1.67	19	14.33	7.69	21.71
BC+C1.0+FA5+T	55	27.9	27.1	1.67	18	4.95	30	17.53
BC+C1.0+FA10+T	54	27.1	26.9	1.68	20	13.64	10	20.95
BC+C1.0+FA15+T	51.5	25.2	26.3	1.68	21	19.63	6	21.62
BC+C1.5+FA5+T	53.2	26.8	26.4	1.67	19	11.29	30	20
BC+C1.5+FA10+T	52.5	26.4	26.1	1.68	20	21.45	10	21.09
BC+C1.5+FA15+T	51.3	26	25.3	1.68	21	23.88	6	22.96

III. RESULTS AND DISCUSSION

Analysis of Results

- Liquid limit decreases with increases with increases in fly ash content. Further increases in various combination of fly ash with cement there is continuous decrease in liquid limit this is due to cat ion exchange between the soil particles and flyash, cement, terrasil.
- Plastic limit decrease with increases in addition of fly ash content this is due to amount of soil to be flocculated soil, decrease the water held in the pores leading to the decrease I plastic limit further increase in various combination of cement fly ash with terrasil there is continuous decrease in plastic limit.
- Plasticity index decreases with increase in percent of cement fly ash with terrasil.
- Free swell decrease with increases in fly ash content, further there is decrease in free swell is due to increase in varying pr
- Shrinkage limit increases with increases in content of fly ash, increase in shrinkage limit is due to flocculation between the clay particles, it further goes increase with varying proportion fly ash, cement, terrasil.
- MDD increases with increase in percent of fly ash with terrasil. Addition of cement with terrasil decrease in MDD this is due to cat ion exchange between the particles of soil forms alumina gel and silica gel in soil compound. Addition of content

decreases the comp active force, repulsive force in soil.

- California bearing ratio increase with increase in percentage of fly ash with terrasil, with addition of various combination of cement, flyash, terrasil there is rapid increase in CBR value. this is due to good compaction and si-o-si bond forms between soil.
- Permeability decreases with increases in combination of flyash, cement ,terrasil,
- Cost analysis for BC soil was done for 15% CBR which is treated with flyash, cement and terrasil is 5112263 rupees while for BC soil untreated having CBR 2% 6104850 rupees .thickness reduced for treated CBR ,GSB replaced with BC soil treated with flyash, cement, terrasil.

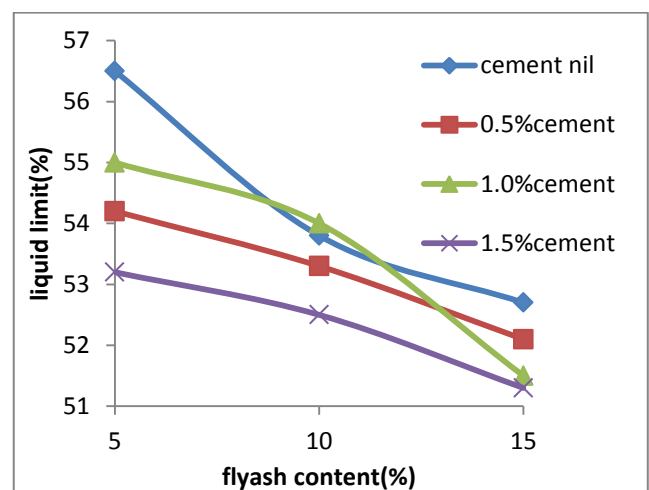


Figure 1. Liquid limit (%) of BC soil with flyash, cement, terrasil

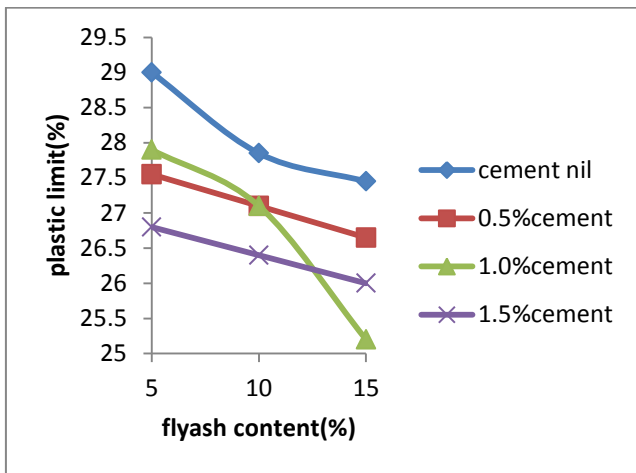


Figure 2. Plastic limit (%) of BC soil with flyash, cement, terrail

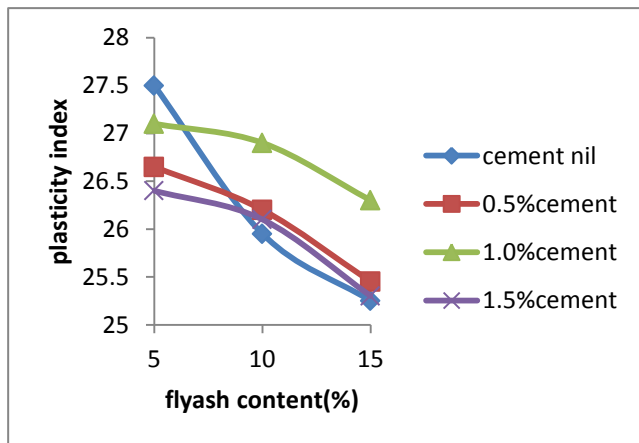


Figure 3. Plasticity index of BC soil with fly ash, cement, terrasil

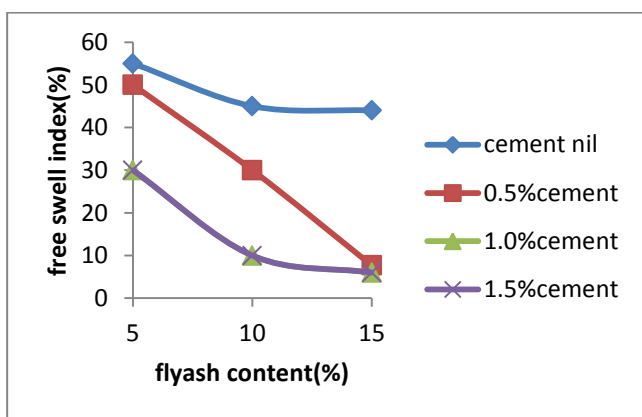


Figure 4. Free swell index (%) of BC soil with flyash, cement, terrail.

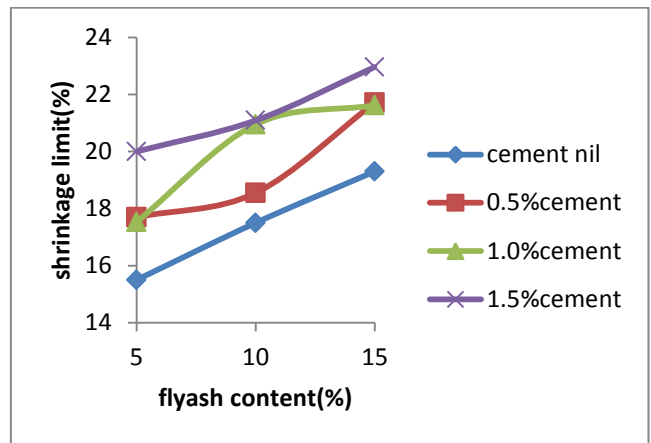


Figure 5. Shrinkage limit (%) of BC soil with flyash, cement, terrail

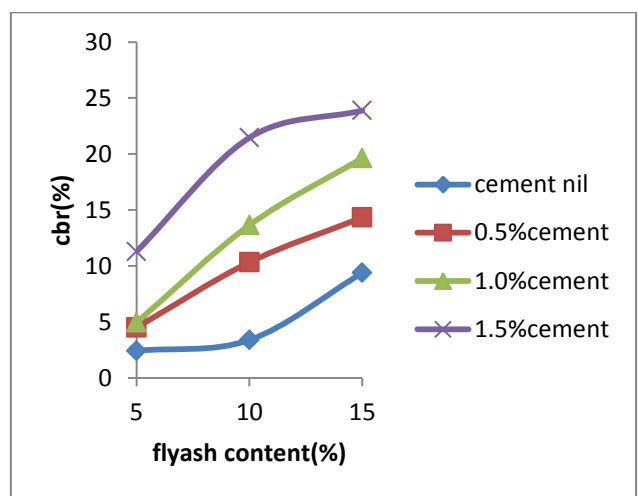


Figure 6. CBR (%) with various flyash, cement, terrail

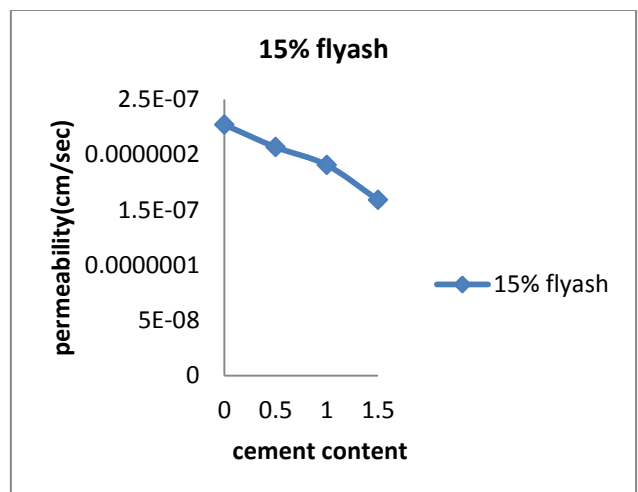


Figure 7. Permeability test of BC soil with fly ash cement terrasil.

- Cost analysis for treated and untreated BC soil

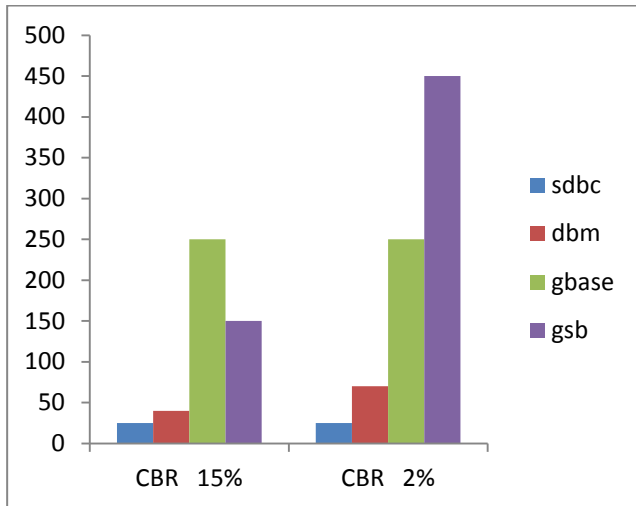


Figure 9. Variation of pavement thickness for CBR value

IV. CONCLUSION

1. When BC soil is treated with various combination of fly ash, terrasil solution CBR value increases. When BC soil is treated with combination of cement and fly ash, terrasil solution, CBR value increases rapidly.
2. Mdd increases with increasing % of flyash, cement, terrasil
3. Liquid limit decreases with increasing % of Flyash, Cement, Terrasil.
4. Plastic limit reduces with increase in % of flyash, cement, terrasil.
5. Plasticity index shows a rapid rate of decrement with increase in % of Flyash, Cement, Terrasil.
6. FSI also reduces with increase in % of flyash, cement, terrasil.
7. Permeability reduces with BC soil mixed with Cement, Fly ash, Terrasil.
8. Cost evaluation was done for 1 km of road was done with fly ash cement terrasil in which cost reduced to 16%.

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