EXPERIMENTAL DESIGN OF STRENGTHENING OF SOIL USING CHEMICAL ADMIXTURES

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ABSTRACT:

Now days, Inefficient properties of soils are a critical issue in engineering projects. In some cases, improve the characteristic of unsuitable soil is a fundamental step for making construction, pavement structures on poor soil sub grades. Black cotton soil usually have the potential to demonstrate undesirable engineering behavior ,such as low bearing capacity, high shrinkage and swell characteristics and high moisture susceptibility. This study reports the improvement in the strength of a locally available cohesive soil by addition of lime, fly ash , cement. Researches were illustrated that adding the additives leads to progress in workability and mechanical behavior of soil with lime, fly ash ,cement as local natural and industrial resources were applied for chemical stabilization. All construction should rest on the soil. So, the soil bearing capacity plays a vital role in constructions. All soils will not have good strength and bearing capacity. The black cotton soils pose many problems in construction. So in this present work the black cotton soil collected from anakapalle has been stabilized by using cement, lime, fly ash. We are conducting the proctor compaction and cbr tests for black cotton soil with addition of admixtures like cement ,lime and fly ash.

KEY WORDS: fly ash, lime, cement

1. INTRODUCTION

In India expansive soils cover about 20% of surface area .in many situations expansive soils cannot be used directly as road service ,foundation layers and as a construction material. expansive soils is a type of clayey soils having montmorillonite material ,which expands when comes in contact with water and shrinks when the water evaporates. Black soil is formed by the weathering of lava (igneous rocks) and cooling of lava after a volcanic eruption. The soil in the Deccan Plateau consist of black basalt soil, which is rich in humus, iron and also contain high quality of magnesia, lime and alumina. Soil color is mainly produced by the minerals present and by the organic matter content. Yellow or red soil indicates the presence of oxidized ferric iron oxides. Dark brown or black color in soil indicates that the soil has a high organic matter content. Wet soil will appear darker than dry soil According Britannica, black soil is found 28 Indian states 1.1**NECESSITY OF SOIL STABILIZATION;** In Vishakhapatnam and particularly anakapalle region top layers comprises of black cotton soil deposits are observed everywhere which is basically a clayey soil comprises of montmortiolite clay mineral as its major constituent.

To make black cotton soils suitable as a good stratum for construction usage improvement in existing properties are necessary. recent studies shows flyash,lime,cement are used for soil stabilization to increase the strength and durability of the black cotton soil.

fly ash: Fly ash is the by product by the burning of powdered coal .fly ash also know as pulverized fuel ash is a coal combustion product that is composed of the particular that are driven out of coal-fired boilers together with the flue gases.

lime: lime is a calcium containing inorganic mineral in which oxides and hydroxides predominate. It is usually an organic sedimentary rock that forms the accumulation of shell,coral,algal and fecal debris. it can be a chemical sedimentary rock.

cement: cement is a binder, a substance used for construction that hardens, and adheres to other materials to bind them together.a powdery substance made by calcining lime and clay, mixed with water to form mortar or mixed with sand,gravel.

Tests conducted for black cotton soil:

PROCTOR COMPACTION TEST: In the standard volume is filled up with soil in three layers .Each layer is compacted by 25 blows of a standard hammer of weight 2.495kg ,knowing the wet weight of the compacted soil and its water content, the dry unit weight of the soil can be calculated.

Y moist=(mass of wet soil in mould*gravity/volume, w=(mass of wet soil-massof dry soil/(mass of dry soil-mass of can)*100 ,Yd =y moist/1+w

The test is repeated at different water contents. The dry unit weight of each compacted sample is plotted against the water content and the curve called compaction curve obtained. Each data point on the curve represents a single compaction test.

Modified proctor compaction test:

The modified proctor test was developed during world war 2 to better simulate the compaction required for air fields to support heavier air craft. The test employs a heavier hammer(4.54 kg) with a height of fall of 457.2mm and 5 layers tamped 25times into a standard proctor mould .

The Indian standard equivalent of the standard proctor test is called the light compaction test (IS :2720, part 7 1974). The volume of the mould is 1000cc ,the weight of hammer 2.6 kg and the drop 310mm .

The Indian standard equivalent of the modified proctor test is called the heavy compaction test(IS:2720 part 8-1983). The weight of hammer is 4.9 kg and the drop 40 mm. The soil is compacted in layers , each layer tamped 25 times.

CBR=(LOAD/STANDARD LOAD)*100

2 EXPERIMENTAL INVESTIGATIONS

The experimental works consists of the following steps:

1) Determination of the maximum dry density (MDD) and the corresponding Optimum moisture content (OMC) of the soil by proctor compaction test.
2) California Bearing Ratio

Preparation of Samples

- Following steps are carried out while mixing the fly ash ,lime ,cement, individually.
- All the soil samples are compacted at their respective maximum dry density (MDD) and optimum moisture content (OMC), corresponding to the standard proctor compaction test.
- The different values adopted in the present study for the percentage of fly ash ,lime, cement ,individually
- In the preparation of samples, if fly ash ,lime, cement , it is not used then the air dried soil was mixed with an amount of water that depends on the OMC of the soil.
- Three samples were prepared for each proportion and average value of the three samples is reported here.

Proctor Compaction Test

This experiment gives a clear relationship between the dry density of the soil and the moisture content of the soil. The experimental set up consists of:

i. Cylindrical metal mould (internal diameter: 10 cm and internal height 12.5cm)
ii. Detachable base plate
iii. Collar (5cm effective height)
iv. Rammer (2.5g)

Compaction process helps in increasing the bulk density by driving out the air from the voids. The theory used in the experiment is that for any compactive effort, the dry density depends upon the moisture content in the soil. The maximum dry density (MDD) is achieved when the soils compacted at relatively high moisture content and almost all the air is driven out, this moisture content is called Optimum Moisture Content (OMC). After plotting the data from the experiment with water content as the abscissa and dry density as the ordinate, we can obtain the OMC and MDD. The equations used in this experiment are as follows:

- Wet density =weight of wet soil in mould (gm)/ volume of mould
- Moisture content= weight of water * 100/ weight of dry soil
- Dry density γ_d(gm/cc)= wet density / (1+ (moisture content / 100))

California Bearing Ratio

Sieve the sample through 4.75 mm IS sieve. Take 5kg of the sample of soil specimen. Add water to the soil in the quantity such that optimum moisture content is reached. Then soil and water are mixed thoroughly. Spacer disc is placed over the base plate at the bottom of mould and a coarse filter paper is placed over the spacer disc. The prepared soil water mix is divided into five. The mould is cleaned and oil is applied. Then fill one fifth of the mould with the prepared soil. That layer is compacted by giving 56 evenly distributed blows using a hammer of weight 4.89kg. The top layer of the compacted soil is scratched. Again second layer is filled and process is repeated. After 3rd layer, collar is also attached to the mould and process is continued. After fifth layer collar is removed and excess soil is struck off. Remove base plate and invert the mould. Then it is clamped to base plate.

A surcharge weight of 2.5kg is placed on top surface of soil. Mould containing specimen is placed in position on the testing machine. The penetration plunger is brought in contact with the soil and a load of 4kg (seating load) is applied so that contact between soil and plunger is established. Then dial readings are adjusted to zero. Load is applied such that penetration rate is1.25mm per minute. Load at penetration of 0.5, 1, 1.5, 2, 2.5, 3,4,5,7.5,10 and 12.5mm are noted.

Table:Standard **load values**

Penetration	**Standard load (kg)**	**Unit standard load 9kg/cm^2**
2.5	1370	70
5	2055	105
7.5	2630	134
10	3180	162
12.5	3600	183

$$CBR = \left\{ \frac{\text{Load sustained by the specimen at 2.5 or 5.0mm penetration}}{\text{Load sustained by standard aggregates at the corresponding Penetration level}} \times 100 \right\}$$

Load = (No. of divisions * 0.303)

- CBR(2.5mm penetration)= $\frac{\text{Load}}{1370}$ x100
- CBR(5mm penetration)= $\frac{\text{Load}}{2055}$ x100

3 RESULTS AND DISCUSSIONS

We conducted many laboratory tests from that we conclude that

BLACK COTTON SOIL

A local expansive soil was used in the experimental programme. The geotechnical properties of soil are:

1. Grain size:
   a) Sand size – 14%
   b) Silt size – 25%
   c) Clay size – 62%
2. Color: Black
3. Odor: Nil

TEST RESULTS

Compaction curve for Black Cotton Soil

Water content in percentage and Dry density in g/cc. At 24%of Water content the Max dry density will be 0.157g/cc

a) Optimum Moisture Content(OMC) =24%
b) Maximum Dry Density(MDD) = 0.157g/cc

EXPERIMENTAL RESULTS OF BLACK COTTON SOIL

1. Compaction Characteristics:
   a) OMC –24%
   b) MDD – 0.157 g/cc

2.CBR

a)2.5 mm=5.44%

b)5 mm=6.924%

CBR RESULTS FOR BLACK COTTON SOIL(UN-SOAKED)

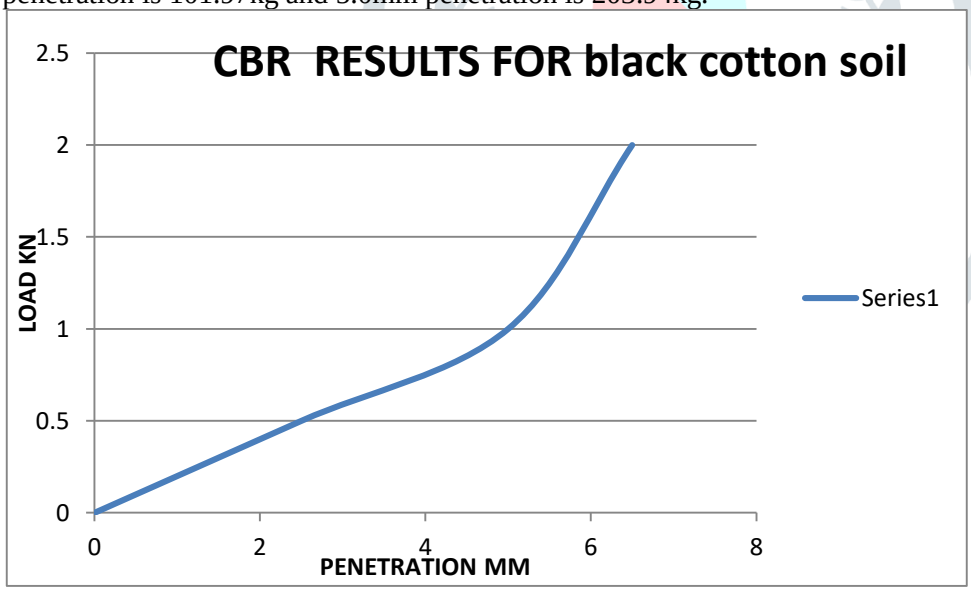
Table:6.1-CBR results for Black cotton soil

PENETRATION IN mm	**STANDARD LOAD IN Kg**	**OBTAINED LOAD IN Kg**	**CBR(%)**
2.5	1370	101.97	5.44
5.0	2055	203.94	6.924

GRAPH FOR BC Soil:

Fig:6.2 Load penetration curve for BC SOIL

In above fig:6.2 x-axis as penetration in mm and y-axis as load in kg. We obtained the value of 2.5mm penetration is 101.97kg and 5.0mm penetration is 203.94kg.



FLY ASH:

TEST RESULTS:

STANDARD PROCTOR TEST:

Table:standard proctor test results

	No. of Trails	Weight of soil(kg)	Weight proportion		Maximum Dry Density(g/cc)	OMC (%)
			Black cotton soil	FLY ash		
COMPACTION CURVE FOR BC SOIL AND fly ash	Trail 8% fly ash & 4% water	2500	2300	200 gms	1.06	17.8
	Trail 8% fly ash &6% water	2500	2300	200 gms	1.200	15.447
	Trail 16% fly ash &2% water	2500	2100	400 gms	1.596	0.171
	Trail 16% fly ash &4% water	2500	2100	400 gms	0.036	22
	Trail 16% fly ash & 6% water	2500	2100	400 gms	0.103	18.27
	Trail 16% fly ash & 8% water	2500	2100	400 gms	0.025	19.71

Fig: Compaction curve @8%flyash & BC SOIL

From the above graph,

a) Optimum Moisture Content(OMC) =17.8%
b) Maximum Dry Density(MDD) = 1.066g/cc

- Standard proctor test has been conducted at 8% of fly ash .In below fig:6.4 x-axis as Water content in percentage and y-axis as Dry density in g/cc. At 6 %of water content the max dry density will be 1.200g/cc as shown in graph below.

Fig: compaction curve@8% fly ash & BC SOIL

From the above graph, it is evident that:

a) Optimum Moisture Content(OMC) =15.447%
b) Maximum Dry Density(MDD) = 1.200g/cc

- Standard proctor test has been conducted at 16% of fly ash .In below fig:6.5 x-axis as Water content in percentage and y-axis as Dry density in g/cc. At 2%of water content the max dry density will be 1.596g/cc as shown in graph below.

Fig: compaction curve@16% fly ash & BC SOIL

From the above graph,

a) Optimum Moisture Content(OMC) =0.171%
b) Maximum Dry Density(MDD) = 1.596g/cc

- Standard proctor test has been conducted at 16% of flyash.In below fig:6.6 x-axis as Water content in percentage and y-axis as Dry density in g/cc. At 4%of water content the max dry density will be 0.036g/cc as shown in graph below.

Fig:6.6 compaction curve@16% fly ash & BC SOIL

From the above graph,

a) Optimum Moisture Content(OMC) =22%
b) Maximum Dry Density(MDD) = 0.036g/cc

- Standard proctor test has been conducted at 16% of fly ash .In below fig:6.7 x-axis as Water content in percentage and y-axis as Dry density in g/cc. At 6%of water content the max dry density will be 5.345*10^-3g/cc as shown in graph below.

Fig: compaction curve@16% fly ash & BC SOIL

From the above graph, it is evident that:

a) Optimum Moisture Content(OMC) =0.182%
b) Maximum Dry Density(MDD) = 5.345*10^-3g/cc

- Standard proctor test has been conducted at 16% of fly ash. In below fig:6.8 x-axis as Water content in percentage and y-axis as Dry density in g/cc. At 8%of water content the max dry density will be 0.025g/cc as shown in graph below.

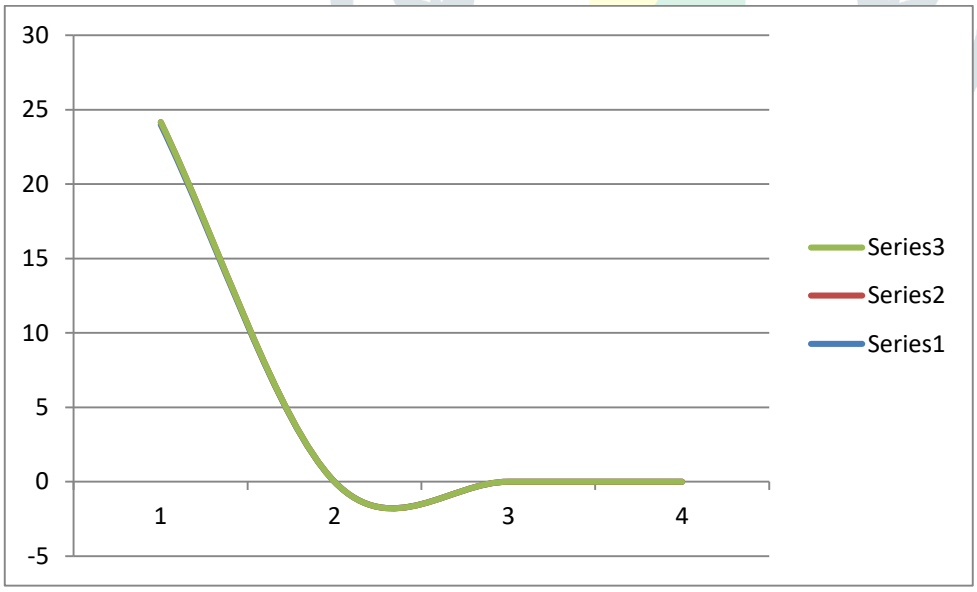


Fig: compaction curve@16% fly ash & BC SOIL

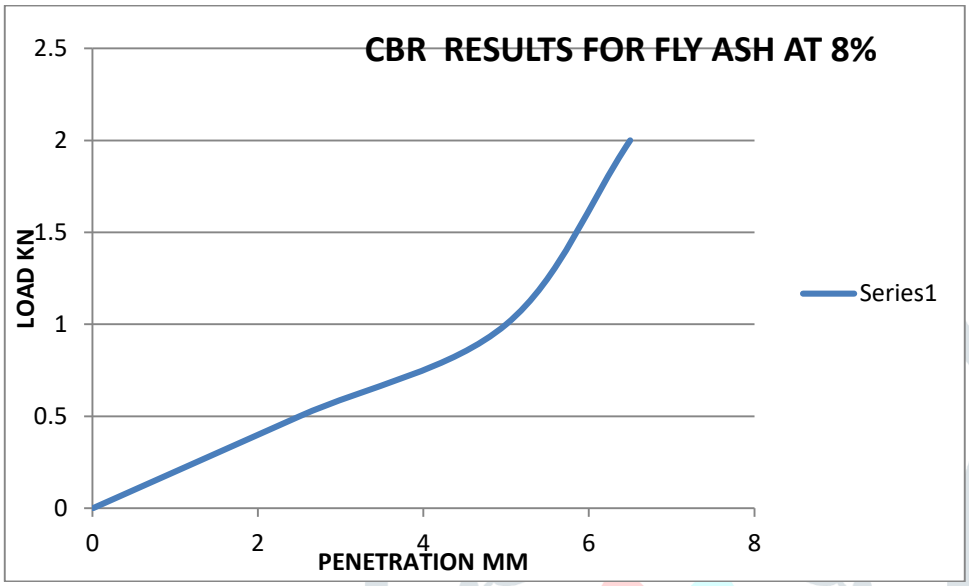
From the above graph,

a) Optimum Moisture Content(OMC) =19.71%
b) Maximum Dry Density(MDD) = 0.025g/cc

CBR RESULTS MIXING FLY ASH(UN-SOAKED)

Table:6.7-CBR results adding 8% fly to BC soil

Deflection	Unit test load	Standard load	CBR%
2.5 mm penetration	101.97	1370	7.44
5 mm penetration	203.94	2550	9.92
10.4 mm penetration	509.855	3180	16



CBR GRAPH@8% fly ash TO BC SOIL

In above fig:6.9 x-axis as penetration in mm and y-axis as load in kg .We obtained the value of 2.5mm penetration is 101.97kg and 5.0mm penetration is 203.94 kg

3.3Lime

3.3.1.41STANDARD PROCTOR TEST

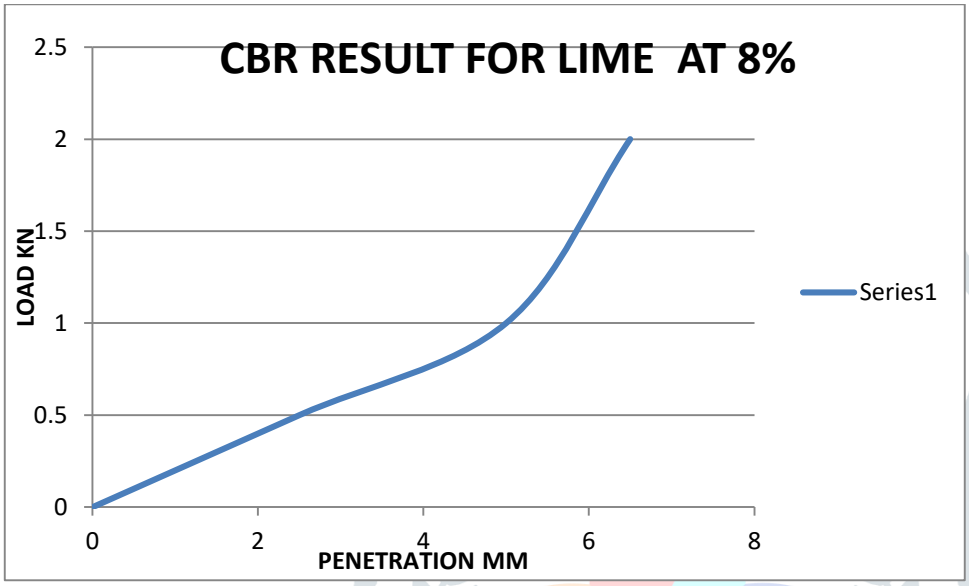
Table standard proctor test results

NO. OF TRAILS	WEIGHT OF SOIL(Kg)	Black cotton soil	Cement (gms)	Maximum dry density(gm/cc)	OMC(%)
Trail 3% lime &4% water	2500	2425	75	1.143	17.35
Trail 3% lime &6% water	2500	2425	75	1.217	15.9
Trail8% of lime and 6% water	2500	2300	200	1.049	18.8
Trail 8% of lime and 8 % water	2500	2300	200	1.161	16

3.3.1.2 CBR

Table :Adding 8% lime to the black cotton soil

DEFLECTION	Unit weight load	Standard load	CBR%
2.5 mm	101.97	1370	7.44
5 mm	203.94	2550	9.92
7 mm	305.913	2630	11.63



3.4.CEMENT:

3.4.1.1 PROCTOR COMPACTION:

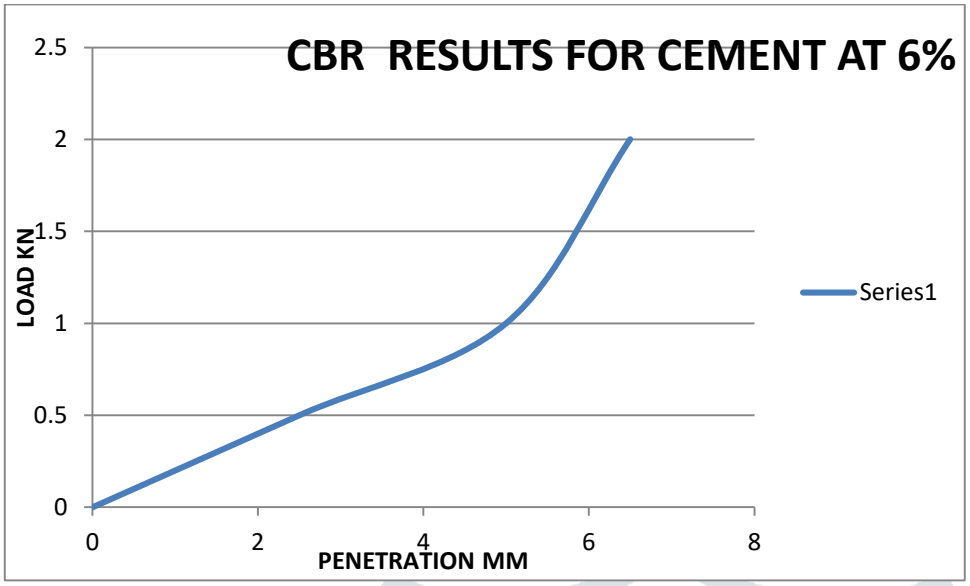
Material	OMC(%)	MDD(gm/cc)
3% cement+4% water +BC soil	15.88	1.329
3% cement+6% water+ BC soil	22.134	0.893
6% cement+4% water+ BC soil	18.9	1.039
6% cement+6% water +BC soil	23.07	0.832

OMC=(MASS OF WET SOIL-MASS OF DRY SOIL)/(MASS OF DRY SOIL-MASS OF CAN)

MDD=Ymoist/1+w

3.4.1.2CBR:

Deflection	CBR%
2. 5mm deflection	7.443%
5 mm deflection	3.998%
6.5 mm deflection	9.924



RESULTS

Comparative study in black cotton soil

S.no.	Test type	Black cotton soil	Bc soil +fly ash (8%)	Bc soil lime (8%)	Bc soil cement (6%)
4	OMC	24%	15%	16%	23%
5	MDD	0.17gm/cc	1.235gm/cc	1.016gm/cc	0.832gm/cc
6	CBR	2.55mm=5.44% 5mm=6.924%	7mm=16% 5mm=9.92% 2.5mm=7.44%	2.5mm=7.44% 5mm=9.92% 7mm=11.63%	2.5mm=3.721% 5mm=4.96% 6.5mm=9.924%

4 CONCLUSIONS

1.The black cotton soil we have taken at anakapalle is having the water content 6.6% as per the code book the water content should be 8.668% .

2)Based on three admixtures the fly ash is having more bearing capacity ,as per cbr results the flyash added to the black cotton soil having cbr value 16%.

3)As compared to the three admixtures fly ash is economical and wastely available material.

4)As compared to the proportions of fly ash the maximum dry density is 1.200 gm/cc and optimum moisture content is 15.44% we get at 8% fly ash and 6% of water to the black cotton soil.

5)As compared to the proportions of cement the maximum dry density is 1.329gm/cc and optimum moisture content is 15.88% we get at 3% cement and 4% of water added to the black cotton soil.

6)As compared to the proportions of lime the maximum dry density is 1.143gm/cc and optimum moisture content is 17.35% we get at 3% lime and 4% water added to the black cotton soil.

7) as compared to all the admixtures the maximum dry density is at 3% cement and 4% water the maximum dry density is 1.329gm/cc and water content is 15.88%

REFERENCES

- Ankit Singh Negi, et al Studies on ''Soil Stabilization using lime '' International Journal of Innovative Research in Science, Engineering and Technology, Vol2, Issue 2, February 2013.
- Bell, F.G, "Lime Stabilization of Clay Minerals and Soils," Journal of EngineeringGeology, Vol. 42, pp. 223-227 1996. As cited by Thian,S.Y, and Lee C.Y, "Shear Strength Behaviour of Mining Sand Treated with Clay and Hydrated Lime, "International Journal of Civil and Structural Engineering Volume 3, No 1, 2012
- MD ALI ASHRAF(2013) "Determination of optimum cement content for stabilization of soft soil and durability analysis of soil stabilized with cement
- ASMA MUHMED(2012)"Effect of lime stabilization on the strength and micro structure of clay"
- VINOD SONTHWAL(2005)Stabilization of soil reinforced with quarry dust
- S. BHUVANESHWARI(2018) Stabilization of expansive soil using fly ash
- CODE BOOK:SP 6 (PART 1) –laboratory testing of soils
- BASIC AND APPLIED SOIL MECHANICS by Gopal ranjan and A.s.rao
- Bhushan S, Kumar R, prakash v. stability of clay soil using rice husk ash and stone dust International Journal Of enhanced research in educational development .2015Oct;3(5):40-47.
- Brooks, R.M., "Soil Stabilization with Fly ash and Rice Husk Ash, "International Journal of Research and Reviews in Applied Sciences, Volume 1, Issue 3, 2009.
- Chittaranjan, M., et al., "Agricultural wastes as soil stabilizers, "*InternationalJournalof Earth Sciences and Engineering*, Volume 04, No 06 SPL, pp 50-51, October 2011.
- Chusilp, N., et.al, "Development of bagasse ash as a pozzolanic material in concrete," Asian Journal on Energy and Environment, p. 149-159, 2009.
- Dilipshrivastava et al, "Effect Of Lime And Rice Husk On Engineering Properties Of Black Cotton Soil ", IJERST,Vol. 3,No. 2, May 2014, pp. 291-297.
- Kanchana latasingh and S.M. Ali Jawaid "Geotechnical properties of soil stabilized with bagasse ash" ,IJBSTR,Vol.1,issue 9(2013).
- K.S GANDHI, "Expansive soil stabilization by using bagasse ash" IJERT, July, issue5.(2012).
- Kumar ,U.A.,&Biradar, K. B. (2014). Soft subgrade stabilization with quarry dust-an industrial waste. IJERT: International Journal Of Research In Engineering and Technology,3(08).
- Laxmikant, Y., et al., "Comparison of Fly Ash and Rice Husk Ash Stabilized Black Cotton Soil, "International Journal of Earth Sciences and Engineering, Volume 04, No 06 SPL, pp. 42-45, 2011.
- Prof.PratikSomaiya, et al, studies on ''Stabilization Of Expansive Soil Using Fly Ash''on 20 july 2015
- Tiwari ,A.&Mahiyar ,H.K(2014). Experimental study on stabilization of black cotton soil by fly ash, coconut coir fibre&crushed glass. : International journal of research in engineering and technology,and advanced engineering (ISSN 2250-2459,ISO 9001:2008 certified journal,volume 4,Issue 11.
- Prof. Krishna Reddy, UIC, 2008, Engineering Properties of Soils Based on Laboratory.
- Punmia B.C. 2007, "Soil Mechanics & Foundations" Laxmi Publications
- Ground Improvement Techniques, December 18, 2008 [online] available at: <http://www.engineeringcivil.com >