International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 3 Issue 5, August 2019 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Soil Stabilization by using Lime & Fly Ash

P. Bala Krishana[1], G. Seshu Pavan[2]

[2]Assistant Professor

[1,2]Sri Sun Flower Engineering College, Challapali, Lankapalli, Andhra Pradesh, India

How to cite this paper: P. Bala Krishana | G. Seshu Pavan "Soil Stabilization by Using Lime & Fly Ash" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-3 | Issue-5, August 2019, pp.663-667, **https://doi.org/10.31142/ijtsrd26442**

IJTSRD26442

ABSTRACT

For any type of structure, the foundation is very important and it has to be strong to support the entire structure. In order for the strong foundation, the soil around it plays a very critical role. To work on soils, we need to have proper knowledge about their properties and factors which affect their behaviour. By consolidating under load and changing volumetrically along with seasonal moisture variation, these problems are manifested through swelling, shrinkage and unequal settlement. In this paper the experimental results obtained in the laboratory on expansive soils treated with industrial waste (fly ash and lime) are presented. A study is carried out to check the improvements in the properties of expansive soil with fly ash and lime in varying percentages. The test results such as liquid limit, standard proctor and differential free swelling test obtained on expansive clays mixed at different proportions of lime and fly ash admixture are presented and discussed in this paper. The results show that the stabilized clay has lesser swelling potential whereas an increase in optimum moisture content has been observed.

INTRODUCTION

Soil is defined as an unconsolidated material, composed of solid particles, produced by physical and chemical disintegration of rocks. Expansive soil is soil can also be termed as clay that has a high potential for shrinking or swelling due to change of moisture content in the environment. This is the main problem in this type of soils.

Clay is a fine-grained soil with particle size smaller than 0.002 mm that combines with one or more clay minerals with traces of metal oxides and organic matter. Montmorillonite, a mineral formed due to the chemical weathering of the volcanic ash is the principal constituent. Expansive soils can be found in almost all the continents. In India, large tracts are covered by expansive soils known as black cotton soils. Geographically, Black Cotton Soils covers about 5.46 lakh sq. km i.e., 16.6 percent of the total geographical area of the total area of our country. The major area of their occurrence is the south Vindhyachal range covering almost the entire Deccan Plateau. Clay minerals are almost ubiquitous in soil and rock and are among the most reactive silicates. They affect the engineering behavior of soil and rock both as materials of construction and as foundation materials. Destructive results caused by this type of soils have been reported in many countries.

Damage Caused to Pavements over Clay Subgrade:

Among the various damages, the damage caused by expansive soils to pavements is more predominant. Majority of the pavement failures is attributed to the poor subgrade conditions. It is a well-known fact that water is the worst enemy of road pavement, particularly in expansive soil areas. Water penetrates into the road pavement from three sides' viz. top surface, side berms and from subgrade due to capillary action. It has been found during handling of various road investigation project assignments for assessing causes of road failures that water has got easy access into the pavement. It saturates the subgrade soil and thus lowers its bearing capacity, ultimately resulting in heavy depressions and settlement. In expansive soil areas, unpaved berms pose the maximum problem as they become slushy during rains, as they are the most neglected lot. Premature failures are common in flexible pavements over clay subgrade. In rainy seasons, the subgrade soil gets softened and intrusion of subsoil into sub base will take place resulting in failure of the flexible pavement. The types of failures in clayey subgrades are as follows

Longitudinal cracks and frost heaving

This is due to differential volume changes that occur in expansive soils. The alternate swelling and shrinkage characteristics possessed by expansive soils results in tracking through the full pavement thickness. When the temperature falls to lesser degrees heaving of pavement may occur due to frosting of water in voids of expansive soils. Due to frost action volume of voids increases, thereby forming a localized heaving up portion in pavements.

Fig1. Longitudinal cracking

Fig .2 Undulated pavement

Classification of soils:

The following systems are used, in general, for the classification of soils:

- Based on particle size
- Textural classification
- Highway research board (HRB) classification
- The unified soil classification system

Table.1 soil classification system based on particle size:

Soil type	Particle size
GRAVEL	80-4.75 mm
SAND	
➢ Coarse	4.750 -2.000mm
➢ Medium	2.000 -0.475mm
➢ fine	0.475 -0.075mm
SILT	0.075-0.002mm
CLAY	Less than 0.002 mm

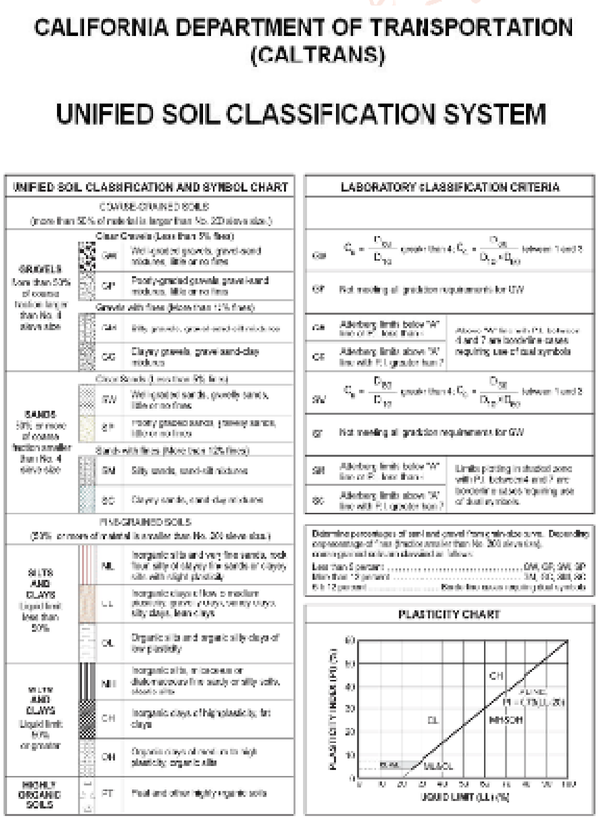


Fig 3.3 soil classification based on the unified classification system

Black Cotton Soil:

Rich proportion of montmorillonite is found in Black cotton soil from mineralogical Analysis. A high percentage of montmorillonite renders high degree of expansiveness. These property results cracks in soil without any warning. These cracks may sometimes Extent to the severe limit like ½" wide and 12" deep. So building to be founded on this soil May suffer severe damage with the change of atmospheric conditions. Black cotton soils Are inorganic clays of medium to high compressibility and form a major soil group in India. They are characterized by high shrinkage and swelling properties. This Black Cotton soils occurs mostly in the central and western parts and covers approximately 20% of the total area of India. Because of its high swelling and shrinkage characteristics, the Black cotton soils (BC soils) have been a challenge to the highway engineers. The Black Cotton soils are very hard when dry but lose its strength completely when in wet condition. It is observed that on drying, the black cotton soil develops cracks of varying depth. As a result of the wetting and drying process, vertical movement takes place in the soil mass. These movements lead to failure of pavement, in the form of settlement heavy depression, cracking and unevenness.

Fig 3 Black cotton soil

Table.1 Soil expansivity predictions by plasticity index:

Degree of expansion	Holtz and Gibbs	Chen
Low	<20	0-15
Medium	12-34	10-35
High	23-45	20-55
Very high	>32	>35

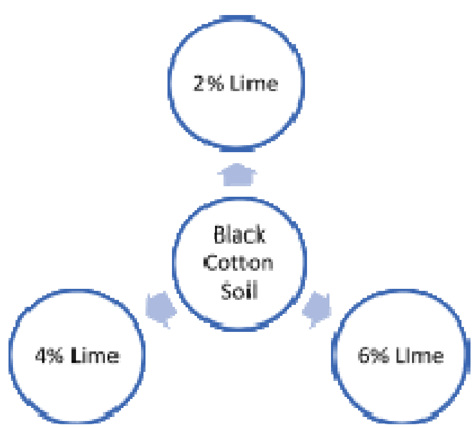


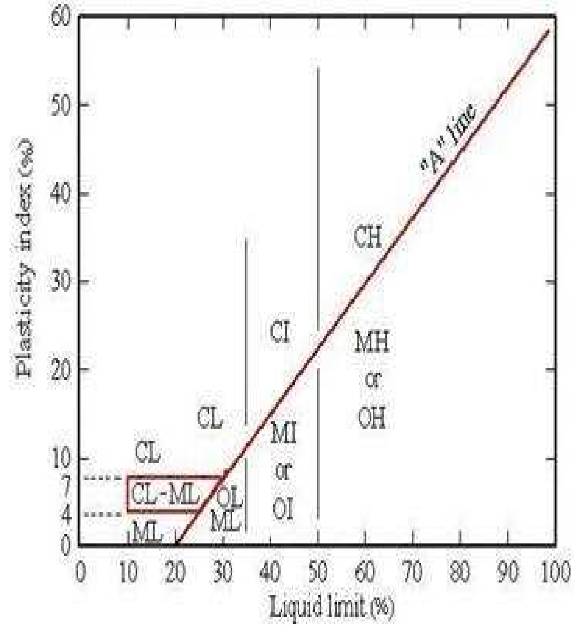
Table2: Schematic Representation of Compaction Test Sample prepared with a variation of Lime%

	Samples Prepared for Compaction Test	Explained in
1	Black Cotton Soil	Section 6.2.1
2	BC + 2% Lime	Section 6.2.2
3	BC + 4% Lime	Section 6.2.3
4	BC + 6% Lime	Section 6.2.4

Table 3: Type of Samples prepared in PHASE 3

Notation	Sample
BC	Black Cotton Soil
L4-FA 0	BC + 4% Lime
L4-FA 5	BC + 4% Lime + 5% Fly ash
L4-FA 10	BC + 4% Lime + 10% Fly ash
L4-FA 15	BC + 4% Lime + 15% Fly ash
L4-FA 20	BC + 4% Lime + 20% Fly ash

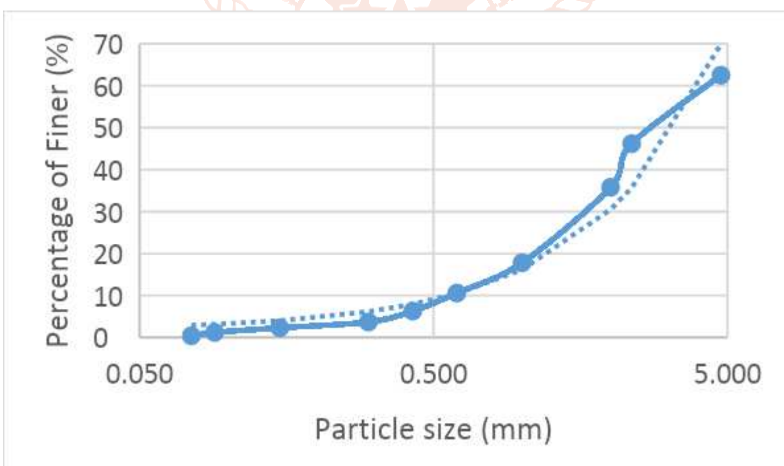
Soil Classification through Plasticity chart (ISC):



Plasticity Chart

Table 4: Sieve Analysis:

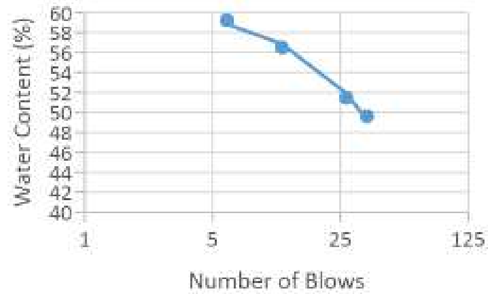
IS Sieve	Weight Retained (g)	Percentage Retained (%)	Cumulative Percentage (%)	Percentage of Finer (%)
4.750	375	37.5	37.50	62.5
2.360	163	16.3	53.80	46.2
2.000	104	10.4	64.20	35.8
1.000	180	18	82.20	17.8
0.600	72	7.2	89.40	10.6
0.425	43	4.3	93.70	6.3
0.300	26	2.6	96.30	3.7
0.150	14	1.4	97.70	2.3
0.090	11	1.1	98.80	1.2
0.075	8	0.8	99.60	0.4
PAN	4	0.4	100.00	0



Graph 1: Sieve Analysis Graph

S. No	Observations & Calculations	Test 1	Test 2	Test 3	Test 4
1	Number of Blows	35	27	12	6
2	Mass of Empty Container (M_1)g	24	32	28	21
3	Mass of Container + Wet Soil (M_2)g	62	78	69	72
4	Mass of Container + Dry Soil (M_3)g	45	41	34	37
5	Water Content W = $(M_w/M_d)x100$ %	49.62	54.17	56.50	59.23

Table 4: Liquid Limit Calculations



Graph 2: Liquid limit determination Graph

Table 5: Observation table to determine the plastic limit:

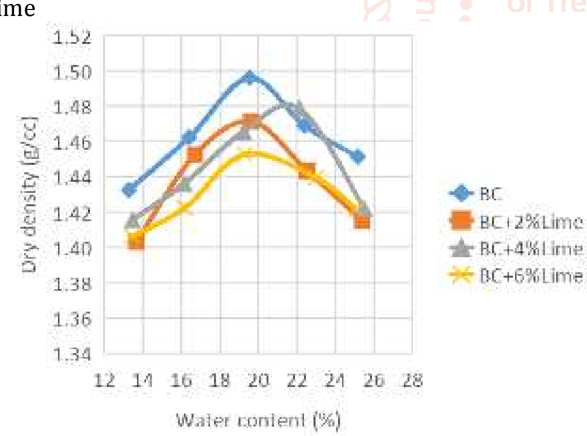
S. No	Observations & Calculations	Test 1	Test 2	Test 3
1	Mass of Empty Container (M_1)g	24	33	28
2	Mass of Container + Wet Soil (M_2)g	69	72	57
3	Mass of Container + Dry Soil (M_3)g	50	51	40
4	Mass of Water $M_w = (M_2 - M_3)$g	19	21	17
5	Mass of Dry Soil $M_d = (M_3 - M_1)$g	26	18	12
6	Water Content $W = (M_w/M_d)$x100 %	24.87	25.49	25.08

Compaction Characteristics:

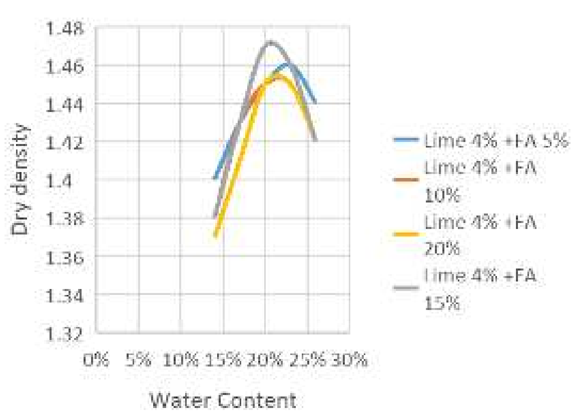
Table 6: Observation table to determine the compaction characteristics:

Height of the Mould	12.73	mm
Diameter of the Mould	15.00	mm
Volume of the Mould	2250	cc
Weight of the Empty Mould	4980	gms

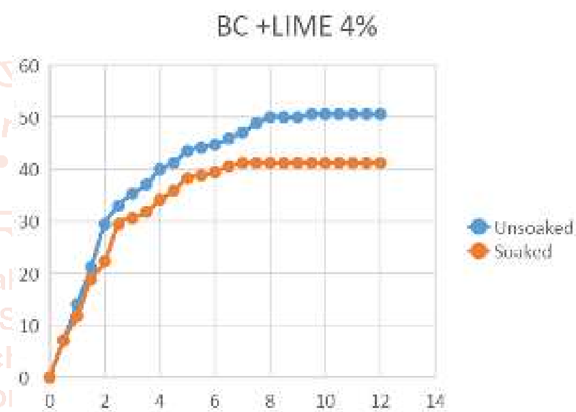
the optimum moisture content (OMC), and maximum dry density (MDD) resulted for each combination of soil with lime



Graph 3: Compaction curves for soil samples with 0%, 2%, 4%, and 6% of lime



Graph 4: Compaction curves for soil samples with 4% lime at different percentages of Fly ash



Graph 5.8.1: Load Vs Penetration graph for BC+4%LIME (Unsoaked & Soaked)

CONCLUSIONS

In this study, the major properties studied are OMC, MDD, CBR, UCS, and Consolidation. Based on all investigations on all samples and when compared with normal soil, the following conclusions were made

Compaction Test and CBR Test:

- In Standard Procter Test, the increase in lime percentage the dry density increases up to 4% and after the MDD value has been decreasing trend. Though, a decrease in OMC has been observed with an increase in lime %
- Taking lime 4% as constant varying different % of fly ash and observe the dry density and MDD values.
- Maximum dry density was increased with the addition of Fly ash
- When 5%,10%,15%,20% FA added, higher MDD observed for 15% FA
- Unsoaked condition of CBR was studied and Peak value was obtained at 20% conditions.
- Soaked condition of CBR was studied and Peak value was obtained at 15% in conditions.

Unconfined compressive strength:

- In UCS, Due to an increase in FA percentage the UCS value having increasing trend with respect to the parent soil.

- In UCS, Due to an increase in percentage, the UCS value has been observed increasing trend up to 20% after that having a decreasing trend with an increase in lime content.
- Lime not only acts as an activator in this case but also reduces the plasticity of the soil.
- FA soil specimen fails by the formation of vertical cracks.
- The Curing period of the mix is a governing parameter as the chemical reaction of stabilizers is depends on it.so it can be concluded that the strength will increase with the increase in the curing period.
- UCS of treated soils was higher than that of untreated soils.
- UCS value of the sample is increased from 0.97 to 8.8 kg/cm^2
- Addition of combination of FA with LIME makes the soil mixes durable, low cost and effective for soil stabilization.
- DFS is greater than 35%, its expansiveness should be considered
- As per Holtz (1969) classified expansive soils based on clay content, based on plasticity Index (%) Swelling potential becomes "Medium"
- As per Chen (1988) classified on expansive soils based on plasticity index (%) Based on plasticity Index (%) Swelling potential becomes "High"

REFERENCES:

[1] "Experimental Study on Stabilization of Black Cotton Soil by Fly Ash, Coconut Coir Fiber & Crushed Glass" by Amit Taiwan, H. K. Mahiyar, International Journal of Emerging Technology and Advanced Engineering – IJETAE, ISSN 2250-2459, Volume 4, Issue 11, November 2014, pg.330-333.

[2] "Effect on Strength Characteristics of Expansive Soil Using Sisal Fibre and Waste Materials" by Amrutha Mathew, Dr. Raneesh. K. Y, International Journal of Science and Research – IJSR, ISSN: 2319-7064, Volume 5, Issue 9, September 2016, pg.1702-1707.

[3] "Compressibility Behavior of Black Cotton Soil Admixed with Lime and Rice Husk Ash" by Dr. A. V. Narasimha Rao, B. Penchalaiah, Dr. M. Chittranajan, Dr. P. Ramesh, International Journal of Innovative Research in Science, Engineering and Technology – IJIRSET, ISSN: 2319 – 8753, Volume 3, Issue 4, April 2014, pg. 11473 – 11480

[4] "Consolidation Characteristics of Fly Ash and Lime Treated Black Cotton Soil" by Vijayakumar Sureban, Proc. Of International Conference on Recent Trends in Transportation, Environmental and Civil Engineering - TECE, 201, pg. 49 – 52.

[5] Soil Stabilization by using PHOSPOGYPSUM & Fly ash. Divya Krishnan, V. Jannani, P. T. Ravichandran, R. Annadurai, Manisha gunturi - International journal of engineering trends and technology – volume 9 Nov 14-mar

[6] "Experimental study on black cotton soil with calcium carbide residue & baggage ash" Neeraj kumrawat, S. K. ahirwar international journal of engineering sciences & management. ISNN: 2277-5528

[7] "Experimental study on strength behaviour of expansive soil treated with PHOSPOGYPSUM and Wood ash" Roshini R, Divvya Krishnan K, P.T. Ravichandran) (International Journal of Science & Research)

[8] "Foundation on expansive soils" Chen FH(1988) Elsevier sciences publishing company, NEWYORK

[9] "Engineering properties of expansive clays" HOLTZ, WG and GIBBS, HJ, TransASCE121

[10] "Volumetric changes in expansive clay soils and control by lime Treatment," Holtz, WG,(1969) second international Research and engineering conferences on expansive clay soils, PP157-173, Texas A& M Press