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Stabilization of Black Cotton Soil Using Admixtures

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Abstract-Stabilization of Black Cotton Soil (BC soil) is studied by using Lime and Fly ash. BC soils are highly clayey soils (Montmorillonite clay mineral). The moisture changes in BC soils, compressibility and plasticity nature can be greatly improved with the addition of Lime and Fly ash. This paper includes the evaluation of soil properties like Optimum moisture content, dry density. Different quantities of Lime and Fly ash (% by weight) are added to the BC soil and the experiments conducted on these soil mixes.

Keywords—Black cotton soil, lime, fly ash, standard proctor test and modified proctor test

I INTRODUCTION

Soil is defined as sediments or other accumulation of mineral particles produced by the physical or chemical disintegration of rocks plus the air, water, organic matter and other substances that may be included. Soil is typically a non homogeneous, porous, earthen material whose engineering behavior is influenced by changes on moisture content and density. Based on the origin, soil can be broadly classified as organic and inorganic. Organic soils are mixture derived from growth and decay of plant life and also accumulation of skeleton or shell of small organism. Inorganic soils are derived from the mechanical or chemical weathering of rocks. Inorganic soil that is still located at the place where it was formed is referred to residual soil. If the soil has been moved to another location by gravity, water or wind, it is referred to as transported soil. Black cotton soils are highly clay soil grayish to blackish in color. They contain montmorillonite clay mineral which has high expensive characteristics. BC soils have low shrinkage limit and high optimum moisture content. It is highly sensitive to moisture changes, compressible subgrade material. Hence the subgrade and its undesirable characteristics to be modified using a suitable stabilization technique.

Stabilization of course-grained soils having little or no fines can often be accomplished by the use of LF combination. Lime and Fly ash in combination can often be used successfully in stabilizing granular materials. LF stabilization is often appropriate for base and sub-base course materials. The water content of the fly ash stabilized soil mixture affects the strength. The maximum strength realized in soil-fly ash mixtures generally occurs at moisture contents below optimum moisture content for density.

II COMPACTION OF SOIL FLY ASH MIXTURES

The density of soil with coal ashes is an important parameter since it controls the strength, Compressibility and permeability. The compacted unit weight of the material depends on the amount and method of energy application, grain size distribution, plasticity characteristics and moisture content at compaction. The variation of dry density with moisture content for fly ashes is less compared to that for a well-graded soil. The tendency for fly ash to be less sensitive to variation in moisture content than for soil is due to higher air void content of fly ash. The higher void content could tend to limit the buildup of pores pressures during compaction, thus allowing the fly ash to be compacted over a larger range of water content.

III. MATERIALS

Naturalsoil:

Natural black cotton soil was obtained from Utnal village, Vijayapur district in Karnataka State. The soil was excavated from a depth of 2.0 m from the natural ground level. The soil is dark grey to black in color with high clay content. The obtained soil was air dried, pulverized manually and soil passing through 425 μ IS sieved was used.

This soil has a property of high moisture retentively and develops cracks in summer. This soil predominantly consists of expansive montmorillonite as the principal clay mineral. The soils were classified in accordance with Indian Standard classification of soils for engineering purpose natural untreated soil used in experiment work are presented in table 1.

Table.I

S.No	Soil properties	Values
1.	Gravel	23.4%
2.	Sand	76%
3.	Silt& clay	0.60%
4.	Liquid limit	38.9%
5.	Plastic limit	14.4%
6.	Plastic index	24.5%
7.	OMC	15.73%
8.	MDD	1.76 gm/cm^3
9.	CBR	2.166

Fly ash

Fly ash is a fine residue collected from the burning of pulverized coal in thermal power plants. The worldwide production of fly ash is growing every year. Fly ash is silt – size non cohesive material having a relatively smaller specific gravity than the normal soils. The basic constituents of fly ash are shown in table 2.

Table.II

S.NO.	Constituent of fly ash	Values
1	Silica (SiO 2)	60.00
2	Alumina (Al 2O3)	25.00
3	Ferric oxide (Fe 2O3)	8.12
4	Calcium oxide (CaO)	6.0
5	Magnesium oxide (MgO)	2.0
6	Titanium oxide (TiO 2)	85.0
7	CaCO3	2.75

Lime

In this project various percentage of lime (i.e. 10%, 15% 20%,25% and 30%) is used as admixture. The basic constituents of lime are shown in table 3.

Table.III

S.NO.	Constituent of fly ash	Values
1	Silica (SiO 2)	60.00
2	Alumina (Al 2O3)	25.00
3	Ferric oxide (Fe 2O3)	8.12
4	Calcium oxide (CaO)	2.9
5	Magnesium oxide (MgO)	0.82
6	Titanium oxide (TiO 2)	0.24
7	Free lime content	2.75

IV METHODS

Compaction (Standard and Modified proctor test) The compaction tests to obtain the moisture-density relationship of the soil-additive mixtures were conducted according to I.S. 2720 (Part viii)-1965.

V RESULT AND DISCUSSION

The tests results of varying % fly ash and lime with BC soil is shown in table 4

S. No	TYPES OF SOIL	Standard procter test		M0dified procter test	
		OMC (%)	MDD (g/cm^3)	OMC (%)	MDD (g/cm^3)
1.	B.C. SOIL	20	1.38	15	1.46
2.	B.C. SOIL+ 10% FLY ASH	16	1.45	12	1.67
3.	B.C. SOIL +15% FLY ASH	15	1.49	10	1.69
4.	B.C. SOIL +20% FLY ASH	14	1.50	8	1.71
5.	B.C. SOIL +25% FLY ASH	12	1.61	10	1.70
6.	B.C. SOIL +30% FLY ASH	15	1.90	12	1.72
7.	B.C. SOIL+10% LIME	14	1.37	11	1.80
8.	B.C. SOIL+15% LIME	14	1.39	16	1.74
9.	B.C. SOIL+20% LIME	14	1.45	18	1.67
10.	B.C. SOIL+25% LIME	12	1.80	19	1.67
11.	B.C. SOIL+30% LIME	13	1.40	19	1.67

Compaction parameters

Optimum Moisture Content (OMC) and Maximum dry Density (MDD) the compaction characteristics for Standard Proctor compactive effort for the black Cotton soil- fly ash mixes reveal that the MDD decreases and the OMC increase With increasing fly ash content. That is shown in fig.1 & fig.2.
The OMC variation wit increasing fly ash content shown in figure 1.

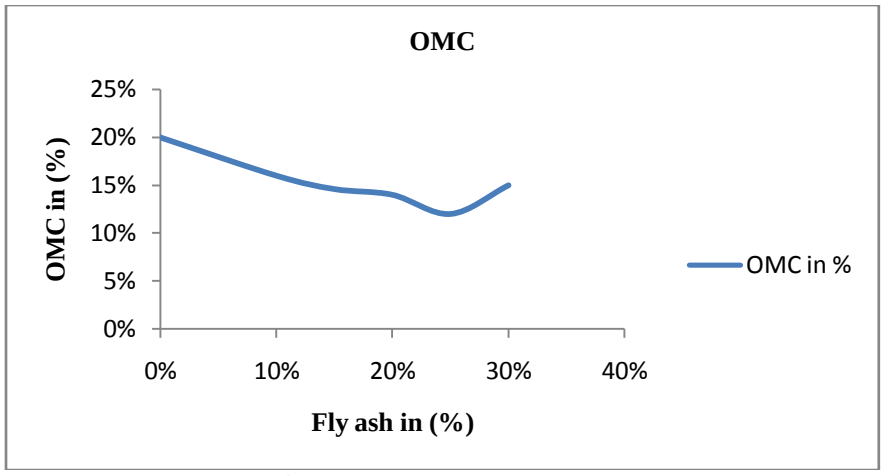

Figure 1.Optimum moisture content

The MDD variation with increasing fly ash content shown in figure 2.

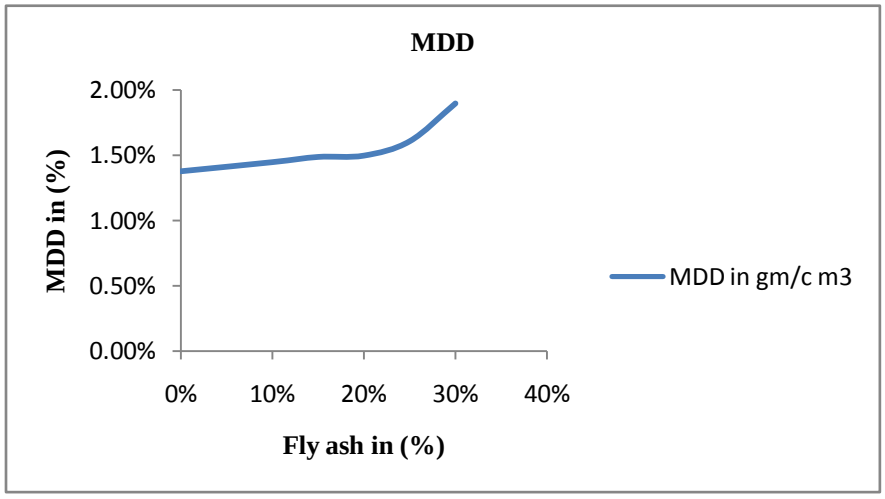

Figure 2.Maximum dry density

Optimum Moisture Content (OMC) and Maximum dry Density (MDD) the compaction characteristics for Standard Proctor compactive effort for the black Cotton soil- lime mixes reveal that the MDD decreases and the OMC increase With increasing fly ash content. That is shown in fig.3 & fig.4.
The OMC variation wit increasing lime content shown in figure 3.

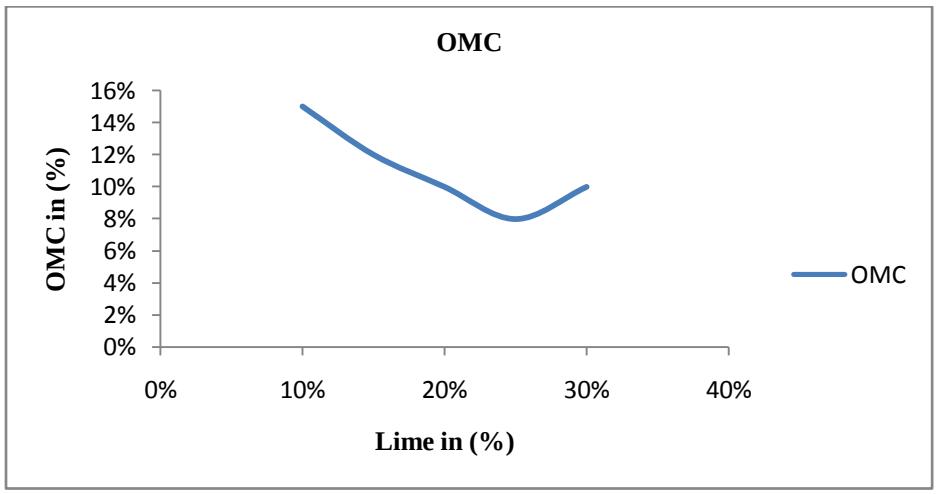

Figure 3. Optimum moisture content

The MDD variation with increasing lime content shown in figure 4.

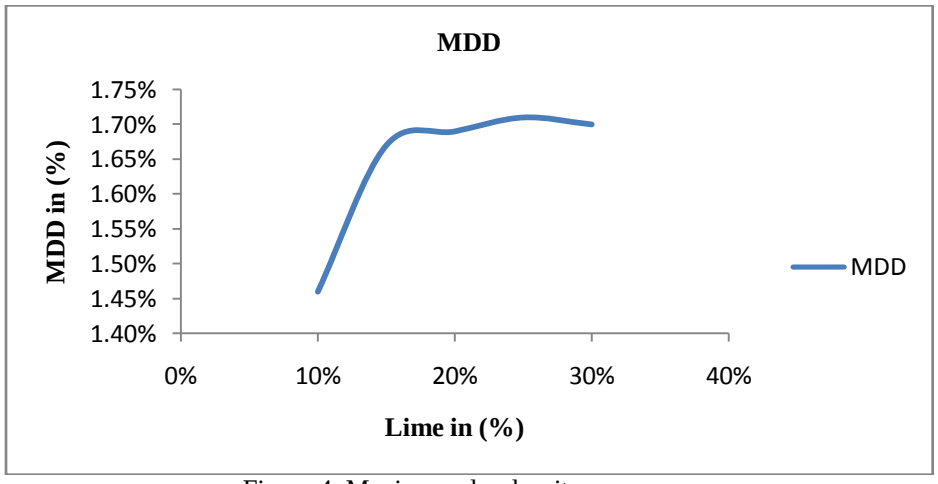

Figure 4. Maximum dry density

Optimum Moisture Content (OMC) and Maximum dry Density (MDD) the compaction characteristics for Modified Proctor compactive effort for the black Cotton soil- fly ash mixes reveal that the MDD decreases and the OMC increase With increasing fly ash content. That is shown in fig.5 & fig.6.

The OMC variation wit increasing fly ash content shown in figure 5

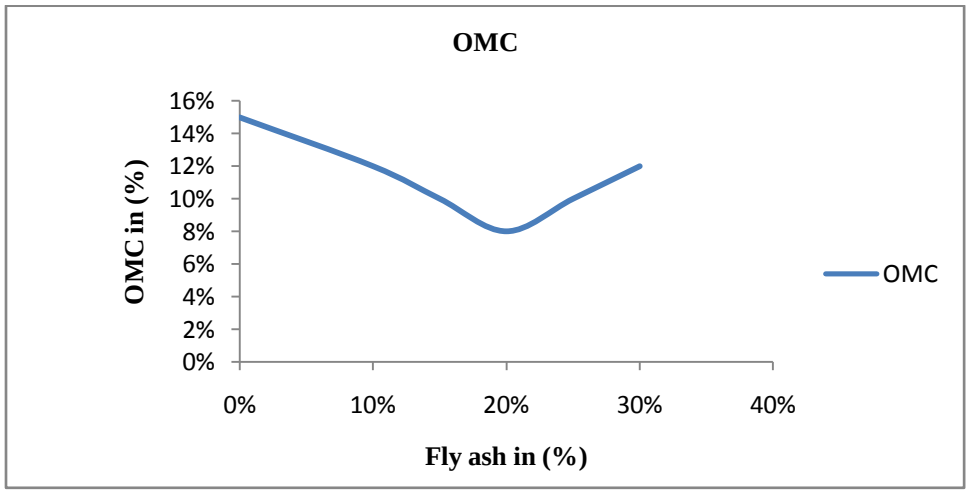

Figure 5. Optimum moisture content

The MDD variation with increasing fly ash content shown in figure 6.

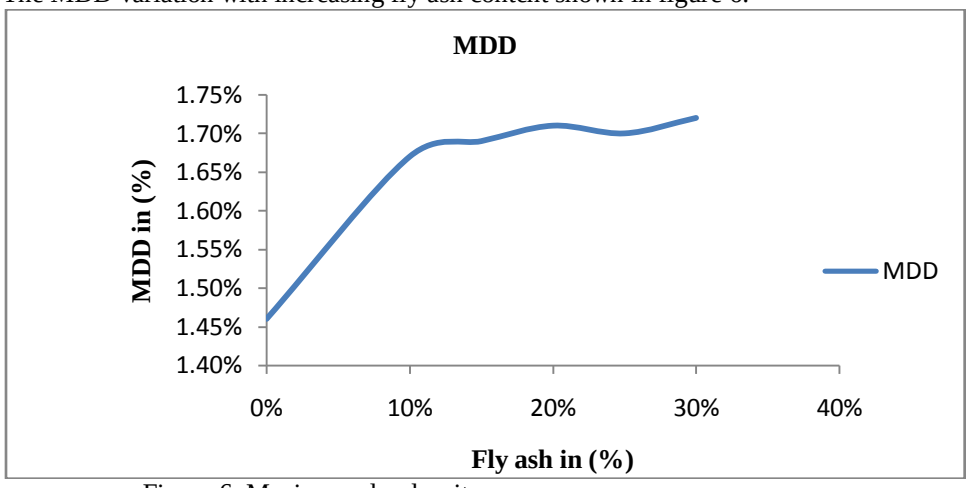

Figure 6. Maximum dry density

Optimum Moisture Content (OMC) and Maximum dry Density (MDD) the compaction characteristics for Modified Proctor compactive effort for the black Cotton soil- fly ash mixes reveal that the MDD decreases and the OMC increase With increasing fly ash content. That is shown in fig.7 & fig.8.

The OMC variation wit increasing fly ash content shown in figure 7

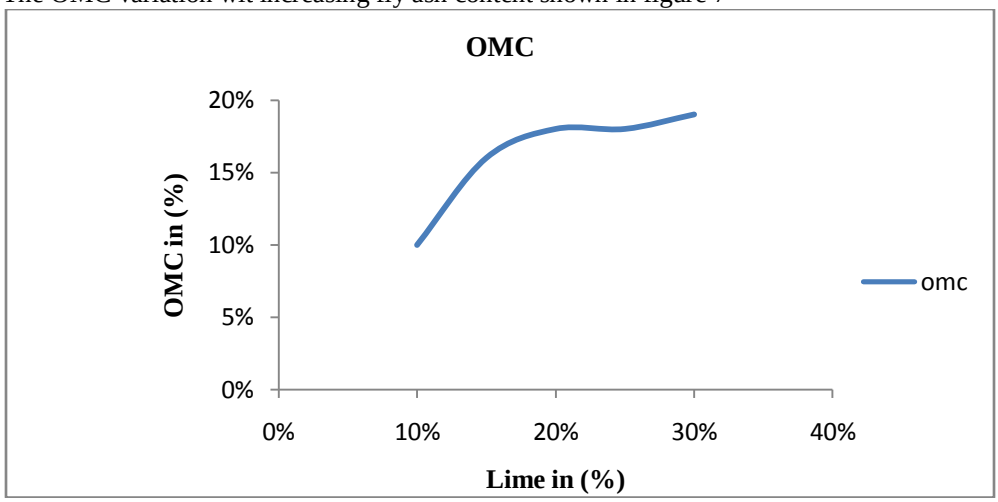

figure 7. Optimum moisture content

The MDD variation with increasing fly ash content shown in figure 8.

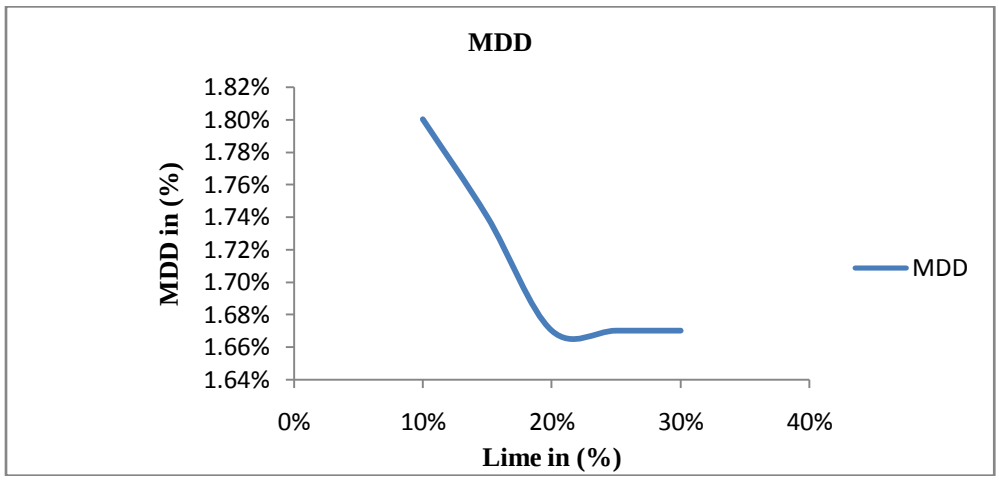

Figure 8. Maximum dry density

5. CONCLUSIONS

1. Compaction characters of BC soil also affected by varying % of fly ash i.e. OMC of BC soil increase with increasing % fly ash and MDD decrease with increase of fly ash likewise Compaction characters of BC soil also affected by varying % of lime i.e. OMC of BC soil increase with increasing % lime and MDD decrease with increase of lime.

2. In respect of the compaction parameters, the maximum dry density is found to increase from 1.45 for FBC-10 mix to 1.9 g/cc for FBC-30 mix ; and further increase in the addition of DFA is observed to decrease it. The optimum moisture content decreases from 16% for FBC-10 mix to 15% for FBC-30 mix.

6. REFERENCE

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