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Performance of Flyash and Lime in Stabilization of Black Cotton Soil

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Abstract—Soil stabilization is one of most important for the construction which is widely used in connection with road pavement and foundation construction because it improves the engineering properties of soil such as strength, volume stability and durability. In the present investigation is to evaluate the compaction and unconfined compressive strength of stabilized black cotton soil using fine and course fly ash mixtures. The percentage of fine and course fly ash mixtures which is used in black cotton soil varied from 10 to 30. In the study concludes that with percentage addition of fine, course fly ash improves the strength of stabilized black cotton soil and exhibit relatively well defined moisture-density relationship. It was found that the peak strength attained by fine fly ash mixture was 25% more when compared to course fly ash

Keywords—Black cotton soil, lime, fly ash, Optimum Moisture Content, Dry Densit

1.INTRODUCTION

Soil stabilization is a technique aimed at increasing the stability of soil mass and chemical alteration of soils to enhance their engineering properties. The soil is hard as long as it is dry but loses its stability almost completely on wetting. On drying, the soil cracks very badly and in the worst cases, the width of cracks is almost 150mm and travel down to 1.5m below ground level.

The construction cost can be considerably decreased by selecting local materials including local soils for the construction of the lower layers of the pavement such as the sub-base course. If the stability of local soil is not adequate for supporting wheel loads, the properties are improved by soil stabilization technique. Fly ash is a waste product from Thermal Power Plants, Which use coal as fuel. It around 100 to 110 million tones of fly ash is being produced from different thermal power plants in India. Stabilization of course-grained soils having little or no fines can often be accomplished by the use of Lime and Fly ash combination. Lime and Fly ash in combination can often be used successfully in stabilizing granular materials. Lime and Fly ash 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. As according to ASTM C-618, two major classes of fly ash are recognized i.e. Class C and Class F. These two classes are related to the type of coal burned. Class F fly ash is normally produced by burning anthracite or bituminous coal while Class C fly ash is generally obtained by burning sub bituminous or lignite coal. Therefore, essentially all Class F fly ashes presently available are derived from bituminous coal. Class F fly ashes with calcium oxide (CaO) content less than 6%, designated as low calcium ashes, are not self hardening but generally exhibit pozzolanic properties. These ashes contain more than 2% unburned carbon determined by loss on ignition test. Quartz, mullite and hematite are the major crystalline phases identified fly ashes, derived from bituminous coal. In the presence of water, the fly ash particles produced from a bituminous coal react with lime or calcium hydroxide to form cementing compounds similar to those generated on the hydration of Portland cement. Class C fly ashes, containing usually more than 15% CaO and also called high calcium ashes, became available for use in concrete industry only in the last 20 years in the 1970s. Class C fly ashes are not only pozzolanic in nature.The specific gravity of fly ash is reported to be related to shape, color as well as chemical composition of fly ash particle.

2.MATERIALS

Black cotton soil

Natural soil sample is taken from Utnal village near Vijayapur(Karnataka),from depth of 2.5 m from ground level. The soil was air dried and pulverized manually. Natural soil has the swelling and shrinkage properties in the present of moisture. This natural soil is grey and black in colour. Basic properties of the 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/cm3
9.	CBR	2.166

Fly ash

Class-F fly ash is taken from Thermal Power Plant Raichur (Karnataka). Fly ash is air dried and pulverized. Fly ash is waste by product of Thermal power plant. Fly ash by itself has little cementatious value but in the presence of moisture it reacts chemically and forms cementatious compounds and attributes to the improvement of strength and compressibility characteristics of 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)	2.9
5	Magnesium oxide (MgO)	0.82
6	Titanium oxide (TiO 2)	0.24
7	Free lime content	2.75

Lime

Lime was generally used from Shastri market Vijayapur (Karnataka).
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)	6.0
5	Magnesium oxide (MgO)	2.0
6	Titanium oxide (TiO 2)	85.0
7	CaCO3	2.75

3. SOIL PREPARATION & EXPERIMENT**:**

Fly ash is mixed in varying percentage of 10%,15%,20% ,25%and 30% with natural soil. lime are mixed in varying percentage of 10%, 15%, 20% ,25%and 30% with natural soil.
The fly ash, lime & black cotton soil are mixed fully on dry weight basis in the suitable required proportions. There are different test Standard Proctor Test, Modified Proctor Test, were performed in laboratory as per IS code standards.

The following tests are conducted:

- Standard Proctor Test

 Modified Proctor

4. RESULT AND DISCUSSION
Standard Proctor Test
Compaction parameters

Optimum Moisture Content (OMC) and Maximum dry Density (MDD) the compaction characteristics for Standard Proctor comp active 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.

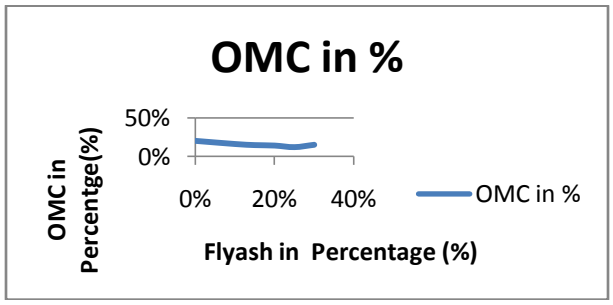

Figure 1
The MDD variation with increasing fly ash content shown in figure 2.

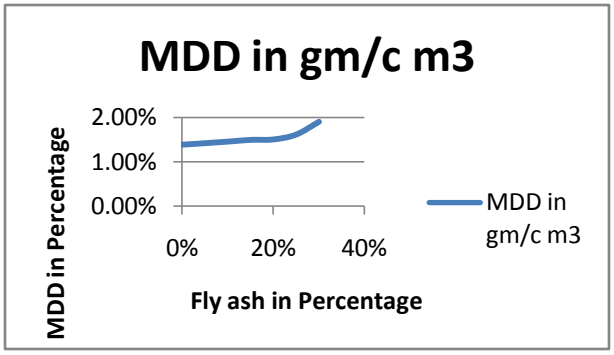

Figure 2

Compaction Character
Optimum Moisture Content (OMC) and Maximum dry Density (MDD) the compaction characteristics for Standard Proctor comp active effort for the black Cotton
soil- lime mixes reveal that the MDD decreases and the OMC increase with increasing lime. That is shown in fig.8 & fig. 9.
The OMC variation wit increasing lime shown in figure 3.

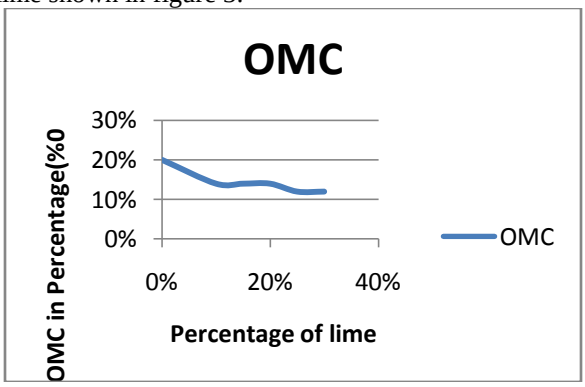

Figure 3

The MDD variation with increasing fly ash content shown in figure 4.

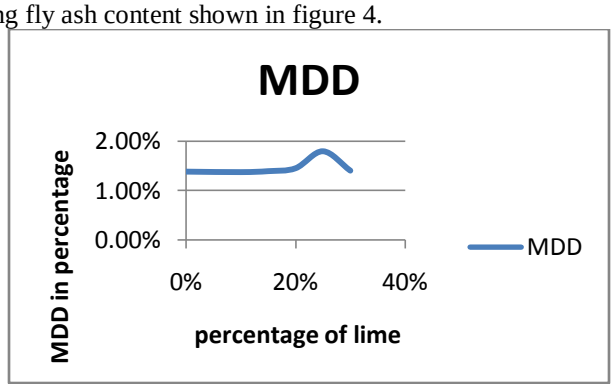

Figure 4

Modified Proctor Test
Compaction parameters

Optimum Moisture Content (OMC) and Maximum dry Density (MDD) the compaction characteristics for modified Proctor comp active 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.

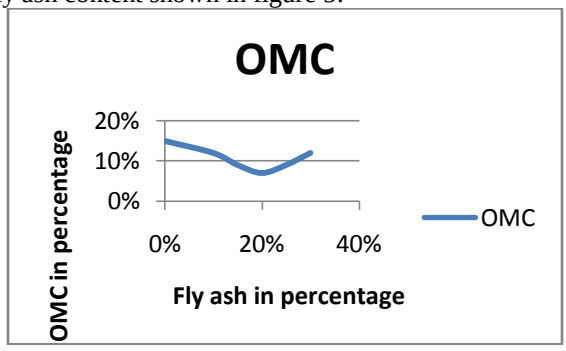

Figure 5

The MDD variation with increasing fly ash content shown in figure

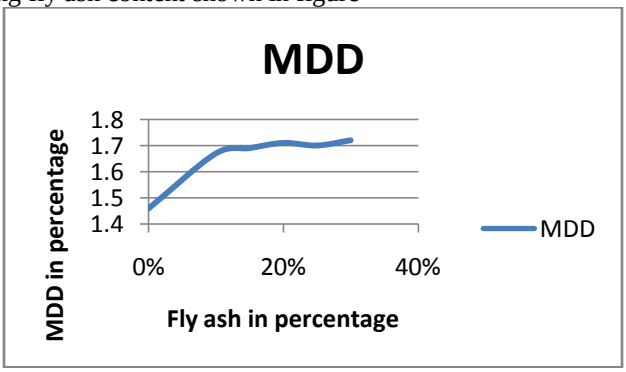

Figure 6

Compaction characters
Optimum Moisture Content (OMC) and Maximum dry Density (MDD) the compaction characteristics for Standard Proctor comp active effort for the black Cotton
soil- lime mixes reveal that the MDD decreases and the OMC increase with increasing lime.

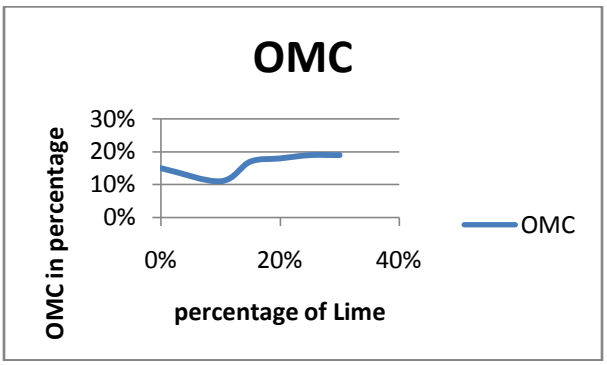

Figure 7

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

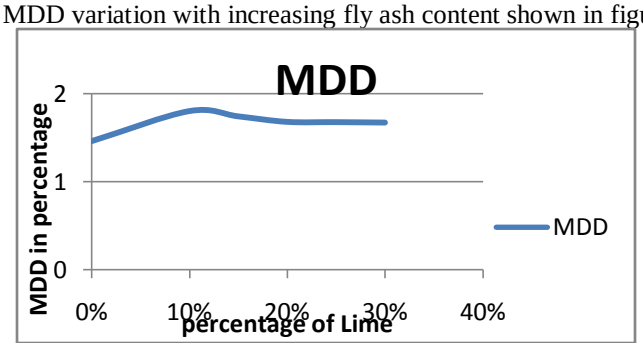

Figure 8

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

Table IV

S. No	**TYPES OF SOIL**	STANDARD PROCTOR TEST		MODIFIED PROCTOR TEST	
		OMC	MDD	OMC	MDD
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	14%	1.49%	10%	1.69%
4.	B.C. SOIL +20% FLY ASH	14%	1.5%	8%	1.71%
5.	B.C. SOIL +25% FLY ASH	12%	1.61%	10%	1.7%

6.	B.C. SOIL +30% FLY ASH	15%	1.9%	12%	1.72%
7.	B.C. SOIL+10% LIME	14%	1.37%	11%	1.8%
8.	B.C. SOIL+15% LIME	14%	1.39%	17%	1.74%
9.	B.C. SOIL+20% LIME	14%%	1.45%	18%	1.678%
10.	B.C. SOIL+25% LIME	12%	1.8%	19%	1.675%
11.	B.C. SOIL+30% LIME	12%	1.4%	19%	1.670%

5. CONCLUSIONS

The following conclusions are drawn from the present investigation:-

- The maximum dry density is in the range between 1.35g/cc 90% of soil and 10% fly ash mixtures and lowest density is about 0.6 gm/cc 70% of soil and 30% of fly ash mixture.
- The decrease in dry density with increase in fly ash is due alteration of gradation of soil.
- Black cotton soil shows appreciable improvement in strength with the stabilizer under unsoaked condition
- Compaction characters of black cotton soil also affected by varying percentage of fly ash.
- Optimum Moisture Content was improved
- Maximum Dry Density was improved

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