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Optimal Blending Of Fly Ash with Geospatial Characteristics of Soil

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Abstract: ***Soil is the basic foundation for any civil engineering structures. It is required to bear the loads without failure. In some places, the soil may be weak which cannot resist the oncoming loads. In such cases, soil stabilization is necessary for this study, fly ash is used as a stabilizing material to stabilize the expansive soil dealing with engineering characteristics as the parameter for it. The present paper describes a study carried out to check the improvement in the properties of expansive soil with fly-ash in varying percentages. Fly-ash is added in 10%, 20%, 30%, and 40% and the change in index properties and engineering characteristics is to be examined. In such cases, soil stabilization is necessary. Numerous methods are available in the literature for soil stabilization. But sometimes, some of the methods like chemical stabilization; lime stabilization etc. adversely affects the chemical composition of the soil. Hence, in this project, we are going to have a check on variation in the properties of soils on the addition of varying percentage of soil.***

Keywords: Fly Ash, Black Cotton Soil, Yellow Soil, CBR.

I. INTRODUCTION

Soil exhibits generally undesirable engineering properties. They expand when wetted and shrink when dried. The main objective of this project is to upgrade soil as a construction material by using fly ash which is by-product material obtained from the thermal power plant (the major source of fly ash).

Fly-ash is a waste product. Disposal and management of fly ash is a major problem in coal-fired thermal power plants. A 500 MW thermal power plant releases 200 mt SO_2, 70 t NO_2 and 500 t fly ash approximately every day. Particulate matter (PM) considered as a source of air pollution constitutes fly ash. The fine particles of fly ash reach the pulmonary region of the lungs and remain there for long periods of time; they behave like cumulative poisons.

All the heavy metals (Ni, Cd, Sb, As, Cr, Pb, etc.) generally found in fly ash are toxic in nature. Therefore bulk stabilization of fly ash becomes very essential in view of huge production. The main objective of this project work is to utilize the fly ash for the improvement of the characteristics of soil.

II. MATERIALS AND METHODOLOGY

Black Cotton Soil and Yellow Soil

Natural black cotton soil and yellow soil were obtained from Jalgaon district in Maharashtra State. The soils were excavated from a depth of 1.5 m from the natural ground level. The black cotton soil is dark gray to black in color with high clay content; 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 yellow soil was pale yellow in color, having a low moisture content as compared to black cotton soil. The obtained soil was air dried, pulverized manually and soil passing through 425 μ IS sieved was used. The tests conducted on the soil to classify the index properties were: Sieve analysis and Atterberg's limits. Also for compaction characteristics, Standard Compaction Test and CBR test were carried out.

Table 1: Physical Properties of Black Cotton Soil

Natural Water Content (%)	Specific Gravity	Grain Size Distribution		Atterberg□s Limit		
		Coefficient of Compressibility (Cc)	Coefficient of Uniformity (Cu)	Liquid Limit %	Plastic Limit %	Plasticity Index
20.28	2.016	1 0.895	11.065	40.35	27.35	13

Table 1: Physical Properties of Black Cotton Soil

Max Dry Density in g/cc	Optimum Moisture Content %	CBR Value
1.38	22.86	7.1

Table 2: SPT and CBR of Black Cotton Soil

Natural Water Content (%)	Specific Gravity	Grain Size Distribution		Atterberg□s Limit		
		Coefficient of Compressibility (Cc)	Coefficient of Uniformity (Cu)	Liquid Limit %	Plastic Limit %	Plasticity Index
17.66	2.01	0.907	10.38	38.76	23.49	15.27

Table 3: Physical Properties of Yellow Soil

Max Dry Density in g/cc	Optimum Moisture Content %	CBR Value
14.6	20.39	8.24

Table 4: SPT and CBR of Yellow Soil

Fly Ash

Fly ash or pulverized fuel ash (PFA) is the residue from the combustion of pulverized coal collected by mechanical or electrostatic separators from the flue gasses or power plants. It constitutes about 75 percent of the total ash produced. The properties and composition of fly Ash vary widely, not only between different plants but from hour to hour in the same plant. Its composition depends on the type of fuel burnt and on the variation of load on the boiler. Fly ash, obtained from cyclone separators is comparatively coarse and contains a large proportion of unburnt fuel, whereas that obtained from electrostatic precipitators is relatively fine having a specific surface of about 3500 cm2/g and may be as high as 5000 cm2/g. Normally it is rather finer than Portland cement. Fly ash consists generally of spherical particles, some of which may be like glass and hollow and of irregularly shaped particles of unburnt fuel or carbon. It may vary in colour from light gray to dark grey or even brown. In the present study, fly ash of class "C" Category procured from Deepnagar thermal power station in Bhusawal, Maharashtra has been used. The fly ash used was grey in color.

Fig. 1: Class 'C' Fly Ash

III. TESTS FOR SOIL MIXTURE

Oven dried samples of black cotton soil and yellow soil sieved through 425mm were mixed with class 'C' fly ash in different percentages such as 10%, 20%, 30% and 40%. The following tests were carried out according to Indian Standards.

Table 5: Indian Standards for different tests

Tests	IS-Codes
Atterberg's Limits	IS-2720-Part-4&5-1985
Standard Proctor Test	IS-2720-Part-7-1980
California Bearing Ratio	IS-2720-Part-16-1979

RESULTS AND DISCUSSION

The unit weight of soil-fly ash mixture is an important parameter since it controls the strength, compressibility, permeability and densification. The strength of soft soil can be altered by the addition of fly ash in varying percentage and the unit weight of the compacted mixtures depends on the method of energy application, the amount of energy applied, Grain size distribution, Plasticity characteristics, and moisture content at compaction. In the present investigation a series of compaction tests were carried out by varying soil and fly ash is compacted at respective optimum moisture content(OMC), the corresponding maximum dry density and optimum moisture content are presented in Table 5 and Table 6.

Table 6: Results of Compaction and CBR Test for Black Cotton Soil

% of fly ash / Properties	0	10	20	30	40
MDD (gm/cc)	1.38	1.48	1.51	1.45	1.38
OMC (%)	22.86	23.9	24.56	23.67	23.1
CBR Value (%)	7.1	9.54	12.97	10	8.34

The variation of maximum dry density, optimum moisture content and CBR value with fly ash content for different proportions of black cotton soil and fly ash mixture is presented in the following figures. It is observed that the maximum dry density and CBR value increases with increase in fly ash content and then decreases after reaching a maximum value at a fly ash content of 20%. The max value of maximum dry density for black cotton soil was observed to be 1.51 g/cc at an optimum moisture content of 24.56%, while the maximum CBR value recorded was 12.97.

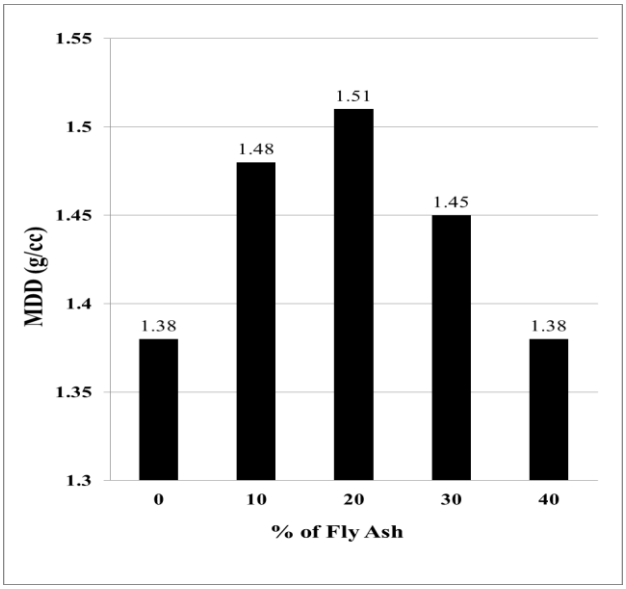

Fig 2: MDD of Black Cotton Soil

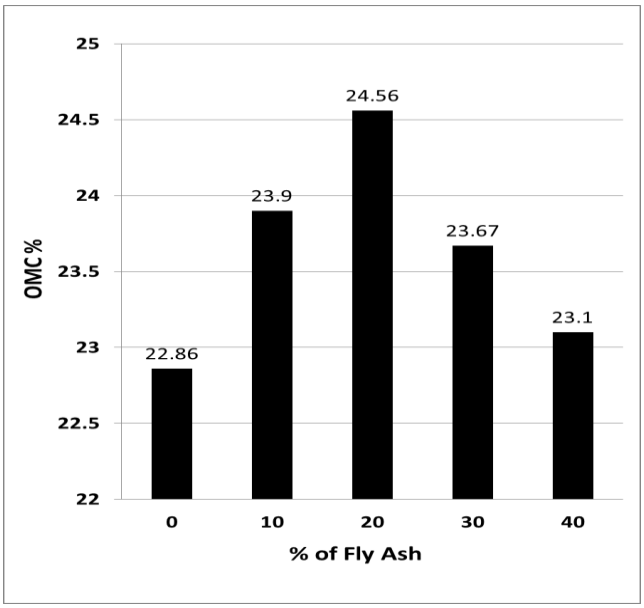

Fig 3: OMC of Black Cotton Soil

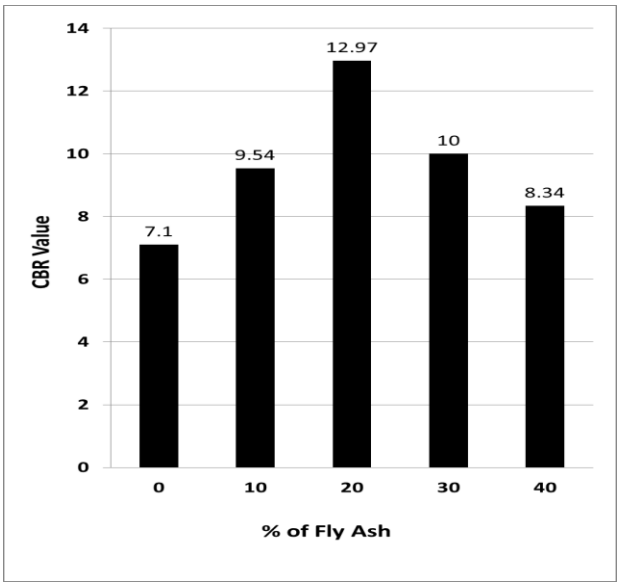

Fig 4: CBR of Black Cotton Soil

Table 7: Results of Compaction and CBR Test for Yellow soil

% of fly ash / **Properties**	0	10	20	30	40
MDD (gm/cc)	14.6	1.51	1.54	1.5	1.44
OMC (%)	20.39	23.28	24.32	23.12	22
CBR Value (%)	8.24	10.55	13.86	11.87	10.21

The variation of maximum dry density, optimum moisture content and CBR value with fly ash content for different proportions of yellow soil and fly ash mixture is presented in the following figures. It is observed that the maximum dry density and CBR value increases with increase in fly-ash content and then decreases after reaching a maximum value at a fly ash content of 20%. The max value of maximum dry density for black cotton soil was observed to be 1.54 g/cc at an optimum moisture content of 24.32%, while the maximum CBR value recorded was 13.86.

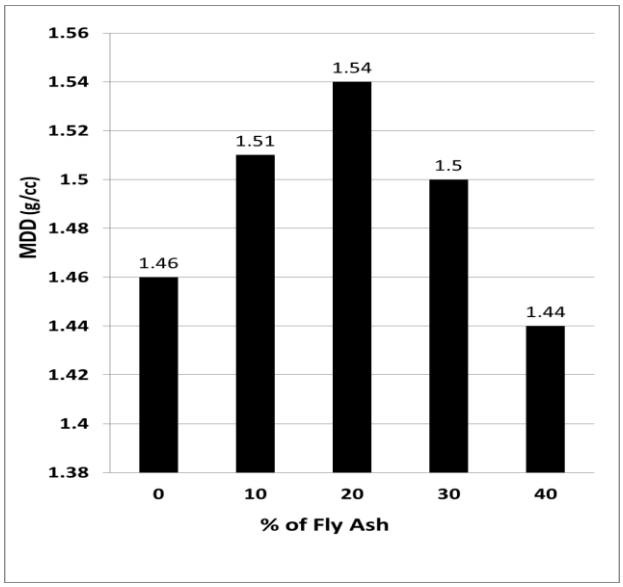

Fig 5: MDD of Yellow Soil

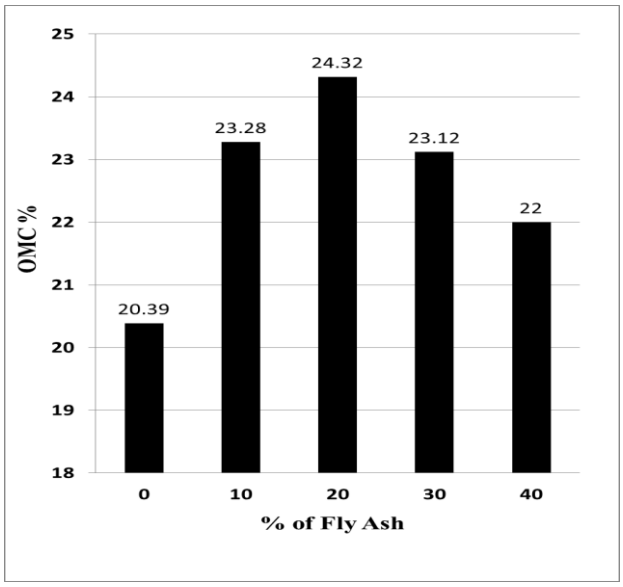

Fig 6: OMC of Yellow Soil

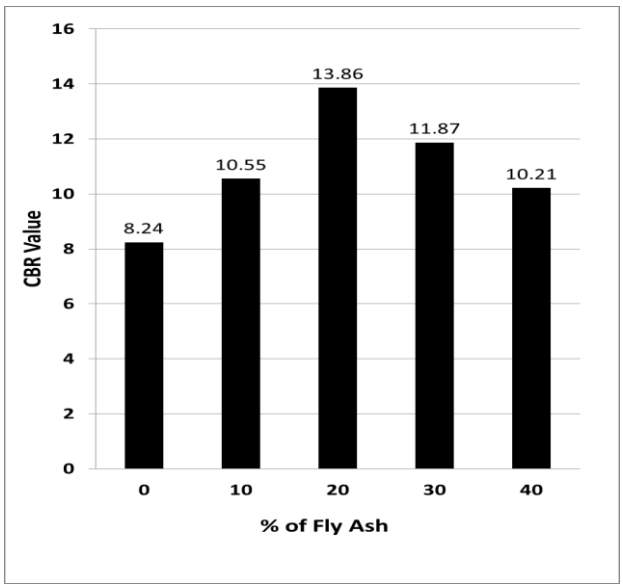

Fig 7: CBR of Yellow Soil

CONCLUSIONS

The conclusions drawn from the above study are as follows:

1. The highest value of maximum dry density is achieved for 80% soil and 20% fly ash mix for both black cotton soil and yellow soil and hence it is the most appropriate soil-fly ash mix [Figure-2&5].
2. On increasing the fly ash content the values of optimum moisture content, maximum dry density and CBR increases and then decreases after reaching a maximum value at 20% fly ash mix.
3. The appropriate soil-fly ash mix considered is soil: fly ash:: 80%: 20% for both black cotton soil and yellow soil

Above results indicate that properties of both black cotton soil and yellow soil are enhanced. Also, the expansive properties of both soils are reduced as the percentage of fly ash is increased.

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