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STABILIZATION OF BLACK COTTON SOIL BY USING FLY ASH

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Abstract — *The objective of this paper is to upgrade expansive soil as a construction material using fly ash, which is waste materials. Soil is a peculiar material. Some waste materials such Fly Ash, rice husk ash, pond ash may use to make the soil to be stable. Addition of such materials will increase the physical as well as chemical properties of the soil. Some expecting properties to be improved are CBR value, shear strength, liquidity index, plasticity index, unconfined compressive strength and bearing capacity etc. The objective of this study was to evaluate the effect of Fly Ash and Rice husk ash to improve the performance of black cotton soil.*

Keywords- Black cotton Soil, Fly ash, Stabilization, Properties.

I. INTRODUCTION

Generally, lands with Black Cotton soils are fertile and very good for agriculture, horticulture, sericulture and aquaculture. Black cotton soils are expansive clays with potential for shrinking or swelling under changing moisture condition. The soils are formed under conditions of poor drainage from basic rocks or limestone under alternating wet or dry climatic conditions. In India, Most Indian Black Cotton Soils occupy an estimated area of 74 million hectare these soils are commonly observed in Maharashtra, western parts of Madhya Pradesh, Gujarat and some parts of Andhra Pradesh, Tamil Nadu, etc. Expansive soils pose problems to civil engineers in general and to geotechnical engineers in particular.

Clay is made up of tiny particles less than 0.002 mm in diameter. By comparison, for this reason, clay soils are considered to be fine textured. Clay soils any type of soil that contains a high percentage of clay particles. When discussing dirt, the term “clay” is basically a catch-all for a family of minerals that are heavy, Sticky, and dense. Clay soil can look different in different places, but it usually acts the same way.

II. SCOPE OF PROJECT

The soil used in the study is brought from Surat (Gujarat) there is composed of clayey soil whose bearing capacity is extremely low. Due to this reason, the roads require periodic maintenance to take up repeated application of wheel loads. This proves to be costly, and at the same time, conditions of roads during monsoon seasons are extremely poor. Therefore, a thought on how to enhance the stability of roads by cheaper means demands appraisal. Soil stabilization can be done using different additives, but use of fly ash which is a waste material from thermal power plants, at the same time difficult-to-dispose material will be much significant.

III. LITERATURE REVIEW

1) **Gyanen. Takhelmayum, Savitha.A.L, Krishna Gudi, "Laboratory study on soil stabilization using fly ash mixtures" Jan 2013 stated [1]**

Abstract: Expansive soils are known as shrink swell or swelling soils. Different clays have different susceptibility to swelling. Such soils expand when they are wetted and shrink when dried. In developing country like India, due to industrial development there is an increase in a demand for energy which has resulted in construction of considerable coal-burning power plants. This development brought with the problem of safe disposal or beneficial utilization of large quantities of by-product like fly ash every year and there is a signal requirement to be carried out toward management of fly ash disposal and utilization. Fly ash is utilized in cement and construction. However, the rate of production is greater than consumption. To utilize the disposal of fly ash and to overcome the swelling and shrinkage behavior of black cotton the use fly ash as a stabilizer.

Conclusion: After conducting tests they conclude: With the increase in water content the dry density decreases up to 20-30% moisture content and with further increase in water content the dry density decreases gradually. The maximum dry density is in the range of 1.35 g/cc for 95% soil and 5% fly ash mixture and lowest density was about 0.6g/cc for 70% soil and 30% fly ash mixture. This variation of density is primarily due to alteration of gradation of soil mixtures. The decrease of the maximum dry unit weight with the increase of the percentage of fly ash is mainly due to the lower specific gravity of the fly ash compared with expansive soil and the immediate formation of cemented products by hydration which reduces the density of soil. The decrease in dry density with increase in fine fly ash content is due alteration of gradation of soil mixtures. Whereas decrease in dry density with the increase in coarse fly ash mixture was attributed due to cat ion exchange between additives and expansive soil which decreases the thickness of electric double layer and promotes the flocculation.

2) **Bindula Bose, "Geo-Engineering properties of Expansive soil stabilization with fly ash" 2012 stated[2]**

Abstract: Expansive soil swell and shrink with change in water content and loose strength upon ingress of water. Excessive heave associated with swelling of expansive soil can cause considerable distress to light weight engineering structures. Several attempts have been made to control the swell-shrink behaviour of these soils. There are several methods that have been used to minimize or eliminate the harmful effects of expansive/soft clayey soils on structures. Fly ash is one of the admixtures that stabilize the black cotton soil and eliminate the harmful effects on the structures.

Conclusion: After conducting tests they conclude: The addition of fly ash reduces the plasticity characteristics of expansive soil. The liquid limit, plastic limit, plasticity index, linear shrinkage decreased drastically and shrinkage limit increased with the addition of fly ash. The free swell Index value and swelling pressure is found to decrease with increase in fly ash content. Grain Size Distribution of soils were altered by the addition of fly ash. The maximum dry density increases up to 20% fly ash mix, and then gradually decreases whereas the optimum moisture content decreased with increase in fly ash content. Maximum Unconfined compressive strength was obtained at 20% fly ash mix with clay and further addition of fly ash reduces the strength. The CBR values of clay-fly ash mixes, tested under un-soaked conditions, shows peaks at 20% and 80% ash content.

IV. MATERIALS AND METHODOLOGY

4.1 FLY ASH

Physical Properties	
Loss of ignition	6%
Moisture content	3%
Chemical composition	
$Sio_2 + Al_2O_3 + Fe_2O_3$	50%
SO_3	5%

Table 3.1 Physical and Chemical properties of class C fly ash

4.3 LAB TESTING
1. Sieve analysis
2. Plasticity index
3. Specific gravity
4. Free Swell Index
5. Mechanical analysis
6. Proctor Compaction Test
7. Box Shear Test

V.TEST RESULTS

1. Atterberg's limits:-

Table no 1 Test Results of Atterberg's Limits

Soil-Fly ash Mixture	Specific Gravity	Liquid Limit	Plastic Limit	Plasticity Index
100% SOIL + 0% FLY ASH	2.51	56%	27%	29%
90% SOIL + 10% FLY ASH	2.23	59%	27%	33%
80% SOIL + 20% FLY ASH	2.18	60%	34%	25%
70% SOIL + 30% FLY ASH	2.15	61%	41%	16%
60% SOIL + 40% FLY ASH	2.10	61%	44%	20%
50% SOIL + 50% FLY ASH	2.08	63%	46%	18%

2. Box shear Test:-

Table no 2 Test results of Box Shear of Surat Sample

	Variation of results in C and Ø of soil with different Fly ash content					
% fly ash	0%	10%	20%	30%	40%	50%
C	0.11	0.10	0.10	0.05	0.05	0.04
Ø	12°	17°	21°	26°	27°	30°

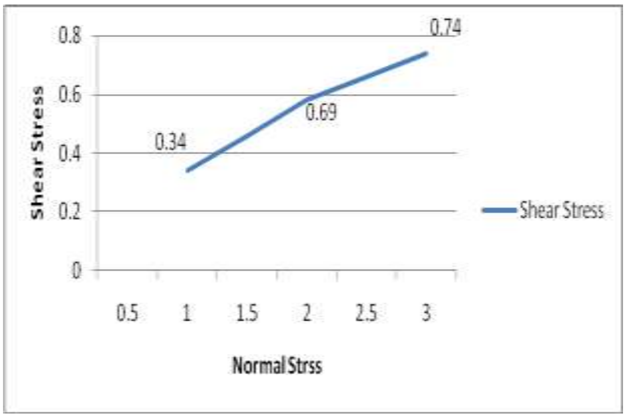

Fig 2.1: 100% Soil + 0% F.A.

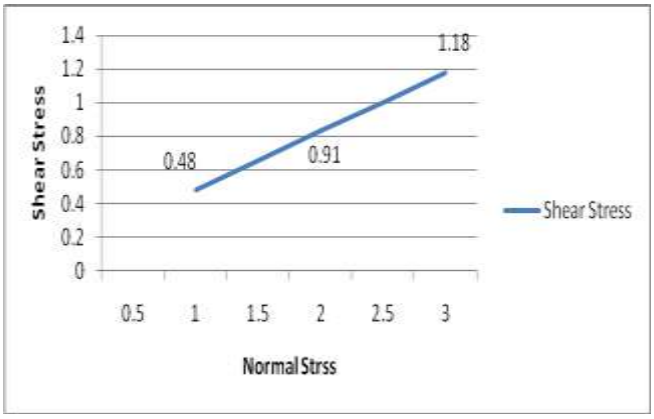

Fig 2.2: 90% Soil + 10% F.A.

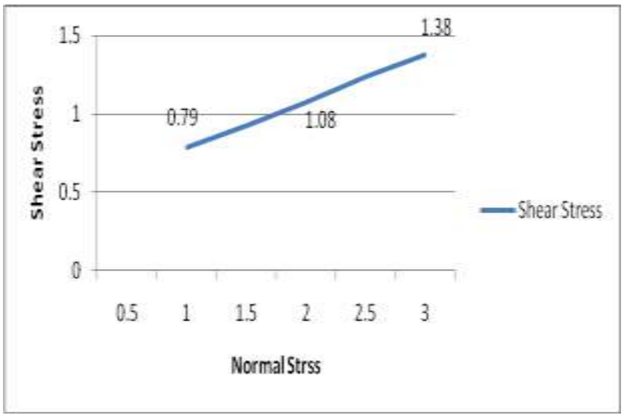

Fig 2.3: 80% Soil + 20% F.A.

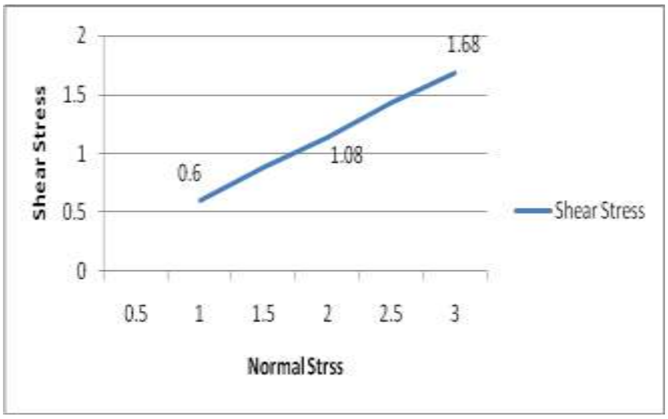

Fig 2.4: 70% Soil +30% F.A.

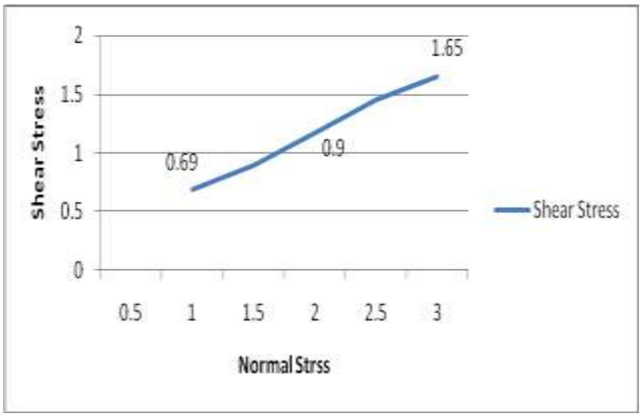

Fig 2.5: 40% Soil + 60% F.A.

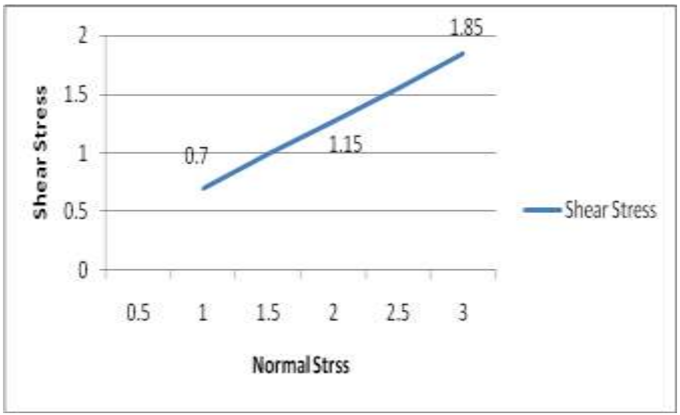

Fig 2.6: 50% Soil + 50% F.A.

3.Sieve Analysis:-

Table no 3 Sieve Analysis of Surat

Sieve No (IS degi.) (1)	Wt. Retained In Cum/Cum			Soil passing as % of soil taken
4.75mm	NIL	NIL	NIL	100
2.00mm	5.0	5.0	10	90
600mic	4.5	9.5	19	81
425mic	NIL	9.5	19	81
212mic	1.0	10.5	21	79
75mic	3.0	13.5	27	73
Passing 75				

4.Summary:-

Table no 3.1 Summary of S.A

Enaction	Total%
Gravel	_
Sand	27
Silt	73
Clay	

V.CONCLUSION

In Surat sample, there is a high content of clay particles (42%). The Liquid limit (61%) and Plastic limit (41%) of this soil is increasing with addition of 30% fly ash. Plasticity index is decreasing with addition of fly ash. The Maximum dry density (1.36g/cc) is decreasing and Optimum moisture content (29.90%) is increasing with addition of 50% fly ash. Angle of friction is increasing (30°) and cohesion is decreasing (0.04) with addition of 50% fly ash.

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