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GEOTECHNICAL STUDY ON BLACK COTTON SOIL TREATED WITH CEMENT AND EAFD – A REVIEW

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Abstract

The study was about improvement of the properties of black cotton soil with electric arc furnace dust (admixtures) with ordinary Portland cement and the determination of the optimum quantity that could be used as road construction material at minimum cost. This admixture is the waste material from the electrical industries. By using of this material as admixture we reduce the environmental hazards. Ordinary Portland cement and (EAFD) is added in the percentages of 0,5,10,15,20 & 0,5,10,15,20 respectively by dry weight of soil.

KEY WORDS:- *OPC, electric arc furnace dust(EAFD), admixture.*

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INTRODUCTION

Soil is naturally available material all the civil engineering structure is always supported on the naturally available soil. All the good land is used by engineer in past and now a days world facing the problems of scarcity of good land for carryout construction work. Soil stabilization is the process of improving the properties of soil to make soil more stable and effective. For any land-based structure, the foundation is very important and has to be strong to support the entire structure. In order for the foundation to be strong, the soil around it plays a very critical role. So, to work with soils, we need to have proper knowledge about their properties and factors which affect their behavior. The process of soil stabilization helps to achieve the required properties in a soil needed for the construction work. From the beginning of construction work, the necessity of enhancing soil properties has come to the light. Ancient civilizations of the Chinese, Romans and Incas utilized various methods to improve soil strength etc., some of these methods were so effective that their buildings and roads still exist. In India, the modern era of soil stabilization began in early 1970's, with a general shortage of petroleum and aggregates, it became necessary for the engineers to look at means to improve soil other than replacing the poor soil at the building site. Soil stabilization was used but due to the use of obsolete methods and also due to the absence of proper technique, soil stabilization lost favor. In recent times, with the increase in the demand for infrastructure, raw materials and fuel, soil stabilization has started to take a new shape. With the availability of better research, materials and equipment, it is emerging as a popular and cost-effective method for soil improvement.

Here, in this project, soil stabilization has been done with the help of OPC and EAFD from waste Electrical materials. The improvement in the shear strength parameters has been stressed upon and comparative studies have been carried out using different methods of shear resistance measurement.

Soil :

Black cotton soil used in the study is procured from visadala area of Andhra Pradesh, India. Extensive laboratory work is carried out to characterize the black cotton soil. the plasticity index is calculated by determining Atterberg's limits. Compaction characteristics are determined by conducting IS light compaction test and strength characteristics by conducting California bearing ratio (CBR) test.

Electric arc furnace dust:

Electric arc furnace (EAF) dust is a waste generated in the EAF during the steel production process. All these elements are emitted to the atmosphere during steel production and are collected by the air pollution control system as a dust.

Cement:

The ordinary Portland cement (OPC) used for the study was purchased in the open market.

LITERATURE REVIEW

K.J.OSINUBI (2011) "Improvement of Black Cotton Soil with Ordinary Portland Cement - Locust Bean Waste Ash Blend **"** This group of soils is usually very poor for engineering use. Ordinary Portland cement (OPC) / locust bean waste ash (LBWA) blend in stepped concentration of 0, 2, 4, 6 and 8% each by dry weight of soil, was used to treat the soil. The CBR value of 5% of the natural soil increased and peaked at 42% for 6% OPC / 6% LBWA treatment, while the durability in terms of resistance to loss in strength increased from 13% for the natural soil to 58%. The strength and durability values also increased with curing ages, thus indicating that the blend has potential for time-dependent increase in strength that will reduce the quantity of cement needed for the construction of low volume roads over the expansive soil. s, it is recommended that about 50% replacement of cement by the ash could be used for the treatment of the soil to achieve a sub base material, thereby reducing the quantity (and cost) of cement needed for stabilization and the environmental menace cause by the waste.

HARESH D. GOLAKIYA (2015) "Studies On Geotechnical Properties Of Black Cotton Soil Stabilized With Furnace Dust And Dolomite Lime**"** Dolomite stone is one type of lime stone and used in Electric Arc Furnace as additive for slag formation having size of 20 to 40 mm aggregate. . Optimum moisture content increases as increase the dolime fine content and maximum dry density decrease with increase in dolime fine content. Optimum moisture content decrease as EAF dust content increase and maximum dry density increase with increase in EAF dust content. The modulus of elasticity value is highest for sample stabilized with 12% dolime fine and intermediate for black cotton soil stabilized with 30% EAF dust and 12% dolime. The soaked CBR value of BC soil is tremendously increase with addition of 30% EAF dust and 12 % lime for 28 days of curing period. Black cotton soil stabilized with 30% EAF dust and 12% dolime fine give good result and 83.33% reduction observed in total thickness of flexible pavement. The higher CBR value leads to lower total pavement thickness of the flexible pavement and this lead to economy in the overall project as the material of construction is reduced.

SHREYAS.K(2017)" Stabilization of Black Cotton Soil By Admixtures**"** The preliminary characteristics of Black cotton soil is which possess poor shear strength with high swelling & shrinkage, thus the behaviour of the soil under the application of loads can be altered by changing its physical & engineering properties. When the BC soil is exposed to variation in climatic condition leads to increase or decrease in swelling & shrinkage ratio, these variations can be minimised by admixtures such as Manufactured sand, cement & fly ash. The present study deals with evaluation of physical & engineering properties of BC soil which is mixed with admixtures in a varying proportions & the results are tabulated by comparing it with standard codes & practises. The experimental study also revealed that with the increase of percentage of Msand with cement & fly ash there is an increase in Maximum dry density values where as there is considerable reduction in optimum moisture content for the given soil by conducting standard proctor test also with the conduction of CBR test by varying the percentage of admixtures like Cement, M–sand and Fly ash in the soil mix, there is a gradual increase in the CBR values with the increase in percentage of stabilizers.

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K.J.OSINUBI(2015) "Improvement of Black Cotton Soil with Ordinary Portland Cement - Locust Bean Waste Ash Blend**"** The preliminary investigation of the Nigerian expansive clay, also known as black cotton soil, collected from New Marte, Borno State, shows that it belongs to A-7-6 (13) in the AASHTO Soil Classification. This group of soils is usually very poor for engineering use. Ordinary Portland cement (OPC) / locust bean waste ash (LBWA) blend in stepped concentration of 0, 2, 4, 6 and 8% each by dry weight of soil, was used to treat the soil. Compaction was carried out using British Standard light (BSL) energy and the three criteria for the evaluation of strength (i.e., UCS, CBR and Durability) were considered. The UCS values of specimens treated with 6% OPC / 6% LBWA increased from 178, 381 and 760kN/m2 for the natural soil to 986, 1326 and 1348kN/m2 when cured for 7, 14 and 28 days, respectively. The CBR value of 5% of the natural soil increased and peaked at 42% for 6% OPC / 6% LBWA treatment, while the durability in terms of resistance to loss in strength increased from 13% for the natural soil to 58%. The strength and durability values also increased with curing ages, thus indicating that the blend has potential for time-dependent increase in strength that will reduce the quantity of cement needed for the construction of low volume roads over the expansive soil.

S. SRIKANTH REDDY(2018) "Lime-Stabilized Black Cotton Soil and Brick Powder Mixture as Sub base Material**"** From the study carried out on brick powder and lime stabilized black cotton soil mixture, the Lime stabilization of black cotton soil under study improved the strength characteristics of the soil, but not to the extent of suitability as sub base material. Mixing 20% brick powder and 80% lime-stabilized black cotton soil improved the maximum dry density and decreased the optimum moisture content in comparison to 4% lime stabilized soil. 80% lime-stabilized black cotton soil and 20% brick powder mixture resulted in increase in the soaked CBR value by about 135%, when compared to 4% lime-stabilized soil, making it satisfactory for use as sub base material. Use of brick powder reduces the content of lime which in turn reduces the cost of project as brick powder is freely available. Also, use of brick powder reduces the problem of waste disposal.

RESULTS

OPTIMUM MOISTURE CONTENT (OMC) AND MAXIMUM DRY DENSITY (MDD):

Optimum moisture content and maximum dry density were determined as per IS: 2720 (part VIII) 1983 by modified proctor test method. Nowadays availability of advanced machinery and compaction techniques justified the selection of modified proctor test for determination of OMC and MDD. The results obtained are tabulated below

Cement (%)	0 % Fe Dust		5 % Fe Dust		10 % Fe Dust		15 % Fe DUST		20% Fe DUST	
	OMC (%)	MDD (gm/ cc)	OMC (%)	MDD (gm/c c)	OMC (%)	MDD (gm/ cc)	OMC (%)	MDD (gm/ cc)	OMC (%)	MDD (gm/ cc)
0	19.2	1.69	18.6	1.785	18	1.805	17	1.83	16.8	1.87
2.5	18.94	1.64	19	1.77	18.37	1.787	17.34	1.81	16.94	1.85
5	18.67	1.61	19.4	1.75	18.74	1.77	17.7	1.79	17.13	1.80
7.5	18.53	1.58	19.76	1.73	19.12	1.752	18.04	1.77	17.42	1.79
10	18.06	1.55	20.15	1.71	19.5	1.735	18.4	1.76	17.59	1.78

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Unconfined Compressive Strength:

For determination of compressive strength, the all the materials EAF dust, CEMENT and black cotton soil passed from 4.75 mm sieve were mixed together in dry condition in required proportion. Then required amount of water (close to OMC) was added in the sample.

CEMENT%	UCC Strength (N/cm^2)				
	0% EAFD	5% EAFD	10% EAFD	15% EAFD	20% EAFD
0	43	44	45	46	47
2.5	50	50	49	48	46
5	56	54	53	52	49
7.5	63	60	57	54	52
10	71	66	61	58	54

CALIFORNIA BEARING RATIO:

The prepared samples were cured in humidity chamber at 30 C temperature and 85% relative humidity. Samples were soaked in water for 3 days prior to testing. The test results are tabulated in the below table.

SL.NO	TYPE OF SOIL	CBR % FOR 2.5 MM PENETRATION	CBR % FOR 5.0 MM PENETRATION
1	PLAIN BC SOIL	2.15	1.96
2	BC-SOIL +10% EAFD +2.5% CEMENT.	3.67	3.24
3	BC-SOIL +10% EAFD +5% CEMENT	5.21	5.11
4	BC-SOIL +10% EAFD +7.5%CEMENT	5.29	5.18
5	BC-SOIL+10% EAFD +10%CEMENT	5.53	5.24

CONCLUSION

Based on the various laboratory tests as per IS standards for the porous concrete by varying the composition the following conclusions are drawn:

1. Replacement of some percentage of cement with EAFD will increase the engineering properties of Black Cotton soil which also increase its stability.
2. With the conduction of CBR test by varying the percentage of admixtures like Cement, EAFD in the soil mix, there is an increase in the CBR values with the increase in percentage of stabilizers.
3. It has been found that with the increase in percentage of EAFD with cement there is an increase in Maximum dry density values where as there is considerable reduction in optimum moisture content for the given soil.
4. By adding of cement and EAFD we get the maximum unconfined compressive strength at 10% of cement.
5. It is one of the economical method of soil stabilization of BC soil where the raw materials are cheaper when compared to other methods of stabilization of soil

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