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STABILIZATION OF MARINE CLAY WITH RICE HUSK ASH AND ALUMINIUM OXIDE

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ABSTRACT: Soil stabilization is defined as the change in geotechnical properties of soil by chemical or physical means in order to enhance the engineering quality of the soil. The main objectives of the soil stabilization are to increase the bearing capacity of the soil, its resistance to weathering process and soil permeability. Infrastructure projects such as highways, railways, water reservoirs, reclamation etc. requires earth material in very large quantity. In urban areas, borrow earth is not easily available which has to be hauled from a long distance. Quite often, large areas are covered with highly plastic and expansive soil, which is not suitable for such purpose. Extensive laboratory / field trials have been carried out by various researchers and have shown promising results for application of such expansive soil after stabilization with additives such as sand, silt, lime, fly ash, Rice husk ash etc. As Rice husk ash is freely available, for projects in the vicinity of a Thermal Power Plants, it can be used for stabilization of expansive soils for various uses. The present paper describes a study carried out to check the improvements in the properties of expansive soil with Rice husk ash in varying percentages. Both laboratory trials and field tests have been carried out and results are reported in this paper. One of the major difficulties in field application is thorough mixing of the two materials (expansive soil and Rice husk ash) in required proportion to form a homogeneous mass. The long-term performance of any construction project depends on the soundness of the underlying soils. Unstable soils can create significant problems for pavements or structures. Stabilization of soil through different chemicals can enhance the strength and behavior of soil. In this project Aluminum oxide is used for binding material. The focus on this research is on the improvement of strength properties of soil.

1. INTRODUCTION: Soil stabilization is a technique introduced many years ago with the aim to improve the properties of soil and make it suitable for specific engineering projects. Several additives which are required for ground modification such as cement, lime, and mineral additives such as fly ash, silica fume, and rice husk ash have been used under various context. Developing countries like India possess abundantly available agro based resources and by products from industries, many of which are utilized along with a variety of low value products. On the other hand developed countries have accepted and followed the concept of no waste and all such materials are termed as new resources for new material development through value addition. Soil stabilization signifies the method to improve the load carrying capacity of soil. It also includes the change in properties like increase in stability, change or improvement in density and swelling behavior, change in chemical properties and water proofing material properties, by means of soil stabilization strength of locally available soil can be improved to desired level. The choice of particular soil stabilization depends on many factors like type and nature of soil, type and importance of project and economy of the project. When locally available material is mixed in suitable proportion in such a way so as to improve the stability of soil, then such technique of soil stabilization is known as proportioning technique. Cementing agents like Portland cement lime and fly ash may also be used to improve the stability of soil. Bitumen has a very distinct property of binding and it can even bind non cohesive material. Lime can be suitably employed in highly plastic soil so as to improve stability of soil. Plastic soil shows varying properties in presence and absence of water. Water retaining agents like calcium chloride can provide the apparent cohesion in case of sands. Heat treatment when given to the plastic soil can improve the properties like shrinkage, swelling, etc. and such improved material can further be used as a stabilizing product in case of so many soils and giving very good result. The mechanism and end products of chemical stabilization varies from chemical to chemical. There are different chemicals used for stabilizing the soil and use of chemicals are common and time saving, resulting improved properties due to interaction between the molecules of clay particle with chemicals.

2. REVIEW OF LITERATURE:

DSV Prasad et al., (2016) Reported that the properties of marine clay are improved with addition of various percentages of Quarry dust as an admixture and Ferric chloride as additive and the deformation & load carrying capacity of treated Marine Clay has been increased greatly. The loss caused due to damaged structures proved the need for more reliable investigation, of such soil and necessary methods to eliminate or reduce the effect of soil volume change. Additives such as lime, fly ash, Portland cement, saw dust and Synthetics are available to lessen these problems when mixed in the proper quantities with problematic soils. These additives may be used separately or in combination based on necessity.

3. MATERIAL USED

Marine Clay: The soil used in this study is marine clay, obtained from Kakinada Sea Ports Limited, collected at a depth of 1.5m from ground level.

Rice Husk Ash: Locally available Rice Husk Ash was used in the present work. The physical properties are determined and presented in Table 1.

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Table 1 Grain Size analysis of Rice Husk Ash

S. No	PROPERTY		VALUE
1	Grain size distribution (percent finer than)	4.75 mm	100
		2.0 mm	96
		0.6 mm	80
		0.425 mm	50
		0.21 mm	29
		0.075 mm	8

Table 2 Constituents & Composition of Rice Husk Ash

CONSTITUENTS	Composition
SiO_2 (%)	86
Al_2O_3 (%)	2.6
Fe_2O_3 (%)	1.8
CaO (%)	3.6
MgO (%)	0.27
Loss in ignition (%)	4.2

Double layer theory

A **Double Layer** (**DL**, also called an **Electrical Double Layer**, **EDL**) is a structure that appears on the surface of an object when it is placed into a liquid. The object might be a solid particle, a gas bubble, a liquid droplet, or a porous body. The DL refers to two parallel layers of charge surrounding the object. The first layer, the surface charge (either positive or negative), comprises ions adsorbed directly onto the object due to a host of chemical interactions. The second layer is composed of ions attracted to the surface charge via the Coulomb force, electrically screening the first layer. This second layer is loosely associated with the object, because it is made of free ions which move in the fluid under the influence of electric attraction and thermal motion rather than being firmly anchored. It is thus called the **diffuse layer**.

The quick lime is more effective as stabilizer than the hydrated lime, but the latter is safer and convenient to handle generally the hydrated lime is used. It is also known as slaked lime. The higher the magnesium content of the lime, the less is the affinity for the water and the less is the heat generated during mixing.

Lime stabilization is not effective for sandy soils however these soils can be stabilized in combination with clay, fly ash and other pozzolanic materials. **Geo textile**

PP woven geotextile-GWF-40-220, manufactured by GARWARE – WALL ROPES LTD, Pune, India, was used in this investigation. The tensile strength of woven Geo textile is 60.00kN/m for warp and 45.00kN/m for weft.

Gravel: For the present investigation, the gravel was collected from Surampalem, East Godavari District, and Andhra Pradesh State, India. The gravel was classified as well graded gravel and was used in this investigation as a gravel cushion on untreated, treated & reinforced marine clay foundation soil bed and also as a sub-base course in all model flexible pavements.The properties of gravel were presented in Table 1 and it was used as sub base in model flexible pavements and as a cushion in foundation soil beds.

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Table 3 Properties of Gravel

Sl.No.	Property	Value
1	Specific Gravity	2.67
2	Grain Size Distribution	
	Gravel (%)	60
	Sand (%)	30
	Silt & Clay (%)	10
3	Compaction Properties	
	Maximum Dry Density kN/m^3	19.92
	OMC (%)	11.55
4	Atterberg Limits	
	Liquid limit (%)	23
	Plastic limit (%)	17
	Plasticity Index (%)	6
5	Soaked CBR (Compacted to MDD &OMC) %	15

Aggregates: Road aggregate of size between 40-20 mm, confirming WBM-III standards was used for the preparation of the base course in the investigation of the modal flexible pavements.

LABORATORY STUDIES: The laboratory studies were carried out on the samples of Marine clay, Marine clay + Rice Husk Ash mixes.

4. PRESENTATION AND DISCUSSIONS ON RESULTS

Table: 4 Optimum moisture content and Maximum Dry Density values of marine clays and Rice Husk Ash

Mix proportion	Water Content (%)	Dry Density (g/cc)
100% Soil	36.00	1.270
85%Soil+15%RHA	27.20	1.430
80%Soil+20%RHA	27.60	1.480
75%Soil+25%RHA	**29.93**	**1.486**
70%Soil+30%RHA	27.3	1.430

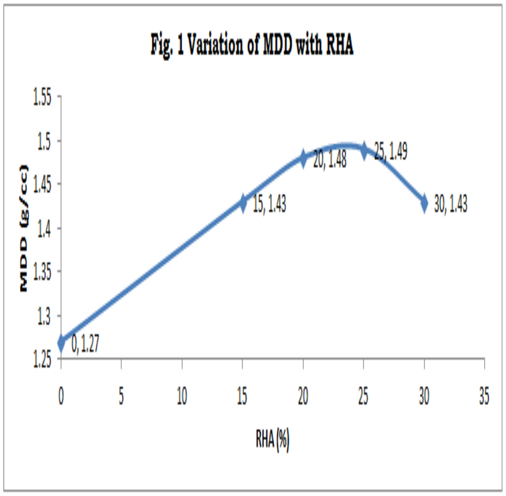

Table: 5 CBR TEST RESULTS FOR MARINE CLAY WITH RICE HUSK ASH:

Mix proportion	Water Content (%)	Soaked CBR
100% soil	36.00	1.754
85%soil+15%RHA	37.26	2.240
80%soil+20%RHA	36.88	2.460
75%soil+25%RHA	**25.71**	**8.290**
70%soil+30%RHA	39.55	2.460

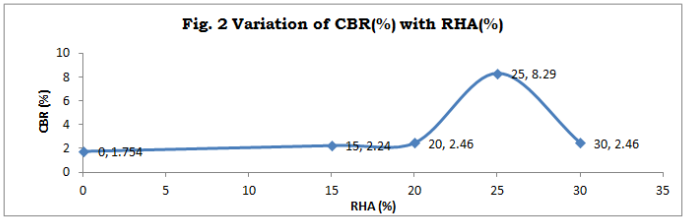

Table: 6 PROCTOR COMPACTION RESULTS OF 75% MARINE CLAY + 25% RICE HUSK ASH + % VARIATION OF ALUMINIUM OXIDE

Mix proportion	Water Content (%)	MDD (%)
100%Soil+25%RHA+4% Aluminium Oxide	38.30	1.113
100%Soil+25%RHA+5% Aluminium Oxide	39.48	1.198
100%Soil+25%RHA+6% Aluminium Oxide	37.48	1.311
100%Soil+25%RHA+7% Aluminium Oxide	22.68	1.401
100%Soil+25%RHA+8% Aluminium Oxide	21.03	1.421
100%Soil+25%RHA+9% Aluminium Oxide	**20.65**	**1.432**
100%Soil+25%RHA+10% Aluminium Oxide	19.96	1.412

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Fig. 3 Variation of MDD with Aluminium Oxide

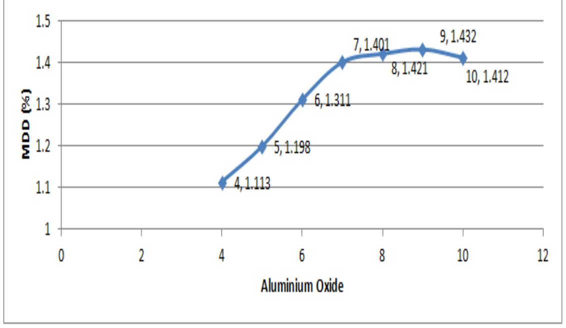

Table:7 CBR RESULTS FOR RICE HUSK ASH TREATED MARINE CLAY WITH VARIOUS PERCENTAGES OF Aluminium Oxide

(75%MC+25%RHA+)	Water Content (%)	Soaked CBR
4% Aluminium Oxide	38.3	3.126
5% Aluminium Oxide	39.48	3.136
6% Aluminium Oxide	37.48	4.256
7% Aluminium Oxide	22.68	5.384
8% Aluminium Oxide	21.03	6.136
9% Aluminium Oxide	**20.65**	**9.632**
10% Aluminium Oxide	19.96	6.272

Fig 4 Variation of CBR Values treated Marine clay with 25% RHA +% Aluminium Oxide

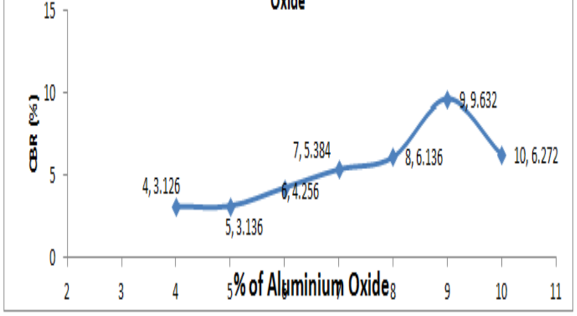

Table :8 Laboratory Cyclic Plate Load test Results of Treated and Untreated Marine Clay Flexible Pavements at OMC & FSC

S. No	Type of Subgrade	Sub-base	Base Course	Ultimate Cyclic Load (kN/m²)		settlements (mm)	
				OMC	FSC	OMC	FSC
1	Marine Clay	----	------	63	31	2.75	4.71
2	Marine Clay + 25% RHA	-----	------	190	127	1.9	2.20
UNTREATED AND TREATED MARINE CLAY MODEL FLEXIBLE PAVEMENTS							
3	Untreated marine clay flexible pavement	Gravel	WBM-II	509	381	2.52	2.21
4	9% Aluminium Oxide +25% RHA + marine clay	Gravel	WBM-II	1300	900	1.6	2.05
5	9% Aluminium Oxide + 25% RHA + marine clay and Geo-textile provided as reinforcement & separator	Gravel	WBM-II	1800	1400	1.80	1.96
6	9% Aluminium Oxide + 25% RHA + marine clay and Geo-textile provided as reinforcement & separator	Gravel	WBM-II	2800	2200	0.83	1.21

5. CONCLUSIONS

- It is noticed that the liquid limit of the marine clay has been decreased by 16.21% on addition of 25% Rice Husk Ash and it has been further decreased by 29.86% when 9% Aluminium Oxide is added.

- It is observed that the plastic limit of the marine clay has been improved by 7.40% on addition of 25% Rice Husk Ash and it has been further improved by 16.29% when 9% Aluminium Oxide is added.

- It is observed that the plasticity index of the marine clay has been decreased by 29.78% on addition of 25% Rice Husk Ashand it has been further decreased by 56.38% when 9% Aluminium Oxide is added.

- It is found that the O.M.C of the marine clay has been decreased by 18.52% on addition of 25% Rice Husk Ashand it has been further decreased by 42.63% when 9% Aluminium Oxide is added.
- It is found that the M.D.D of the marine clay has been improved by 17.00% on addition of 25% Rice Husk Ashand it has been improved by 12.70% when 9% Aluminium Oxide is added.

- It is observed that the C.B.R. value of the marine clay has been

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increased by 282.0% on addition of 25% Rice Husk Ash and it has been further improved by 449.14% when 9% Aluminium Oxide is added.

- It is observed that the DFS value of the marine clay has been decreased by 72.80% on addition of 25% Rice Husk Ash and it has been further decreased by 77.28% when 9% Aluminium Oxide is added.

- It was noticed from the laboratory investigations of the cyclic plate load test results that, the ultimate load carrying capacity of the treated marine clay model flexible pavement has been increased by 450% at OMC and 477% at FSC when compared with untreated marine clay model flexible pavement.

The soaked CBR of the soil on stabilizing is found to be 9.632%and is satisfying standard specifications. So finally it is concluded from the above results that the stabilized marine clay is suitable to use as sub grade material for the pavement construction and also for various foundations of buildings.

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