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A Laboratory Study of Cyclic Plate Load Test on Lime and Rice Husk Ash Treated Marine Clay Subgrade Flexible Pavements

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ABSTRACT: *Marine clay is an impermeable soil, meaning it holds water, as opposed to permeable soil that allows water to rapidly drain, like a gravel or sand. It is also an expansive soil, such as the marine clay which predominates in almost all countries of the world, which when shrinking or expanding, can damage foundations and structures. The shrink and swell movements are due to changes in soil moisture. Providing uniform soil moisture next to and under your foundation is the only best thing to reduce or minimize the damaging effects of expansive soil. These soils are highly saturated, soft, sensitive and normally consolidated. These usually have low density and low shear strength. The present study involves a study on the strength characteristics of Rice Husk Ash and Lime treated marine clay based on the cyclic plate load test criteria.*

Keywords: *Marine clay, RHA, Lime, OMC, MDD, FSC, Cyclic Plate Load Test.*

I. INTRODUCTION

Many innovative foundation techniques have been devised as a solution to the problem of marine soils. The selection of any one of the techniques is to be done after detailed comparison of all techniques for the well suited technique for the particular system. The various additives used for stabilizing expansive soils are lime, calcium chloride, Rice Husk Ash, fly ash, gypsum, Saw dust and others.

Zhang (2002) undertook an experimental program to study the individual and admixed effects of lime and fly ash on the geotechnical characteristics of soil. They observed reduction in free swell and increase in CBR value. Later on it was observed that lime-fly ash admixtures reduced the water absorption capacity and compressibility of soils.

Phani Kumar and Radhey Sharma (2004) reported that fly ash can be used as an additive in improving the engineering characteristics of soils. They observed the decrease in plasticity and hydraulic conductivity and increase in penetration resistance of blends with increase in fly ash content.

Various remedial measures like soil replacement, pre-wetting, moisture control, chemical stabilization have been practiced with varying degrees of success. Unfortunately the limitations of these techniques questioned their adaptability in all conditions. So work is being done all over, to evolve more effective and practical treatment methods, to alleviate the problems caused to any structures laid on marine clay strata.

Investigation on chemical stabilization (Petry and Armstrong, 1989; Prasada Raju, 2001) revealed that electrolytes like potassium chloride, calcium chloride and ferric chloride may be effectively used in place of conventionally used lime, because of their ready dissolvability in water and supply of adequate cations for ready cation exchange.

II. OBJECTIVES OF THE STUDY

The objectives of the present experimental study are

- To determine the properties of the Marine clay and Rice Husk Ash.
- To evaluate the performance of Marine clay when stabilized with Rice Husk Ash as an admixture and lime as an additive.
- To study the cyclic plate load characteristics of marine clay when stabilized with optimum mix of Rice Husk Ash and lime

III. MATERIAL USED

Marine Clay

The soil used in this study is Marine Clay soil, obtained from Kakinada Sea Ports Limited, Collected at a depth of 1.5m from ground level. Kakinada port is situated on the east coast of India at a latitude of 16^0 56' North and longitude of 82^0 15' East.

Rice Husk Ash

Locally available Rice Husk Ash was used in the present work.

Lime

Commercial grade lime mainly consisting of 58.67% CaO and 7.4% Silica was used in the study.

Geotextile

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

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.

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.

IV. LABORATORY TEST RESULTS

Table1: Variation of OMC and MDD with % variation in RHA

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

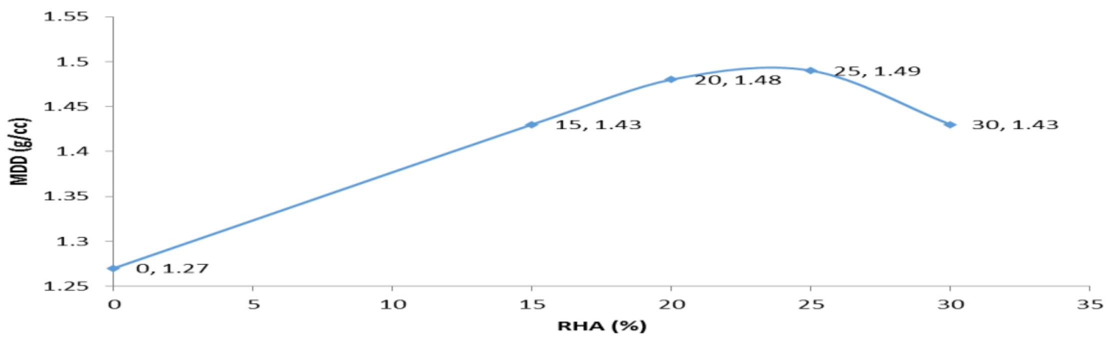

Fig1: Curve showing variation of MDD with % variation of RHA

Table2: variation of soaked CBR values 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

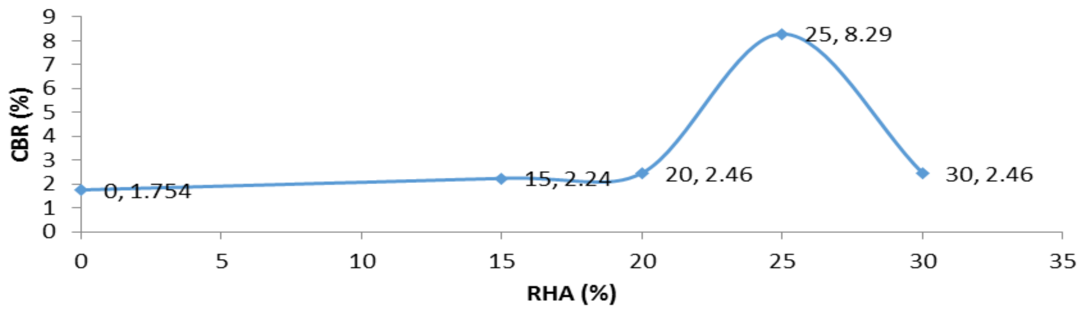

Fig2: CBR Curve with % variation of RHA

Table3: Variation of MDD values with Lime (%)

MIX PROPORTION	WATER CONTENT (%)	MDD (%)
100%SOIL+25%RHA+4%LIME	38.30	1.113
100%SOIL+25%RHA+5%LIME	39.48	1.198
100%SOIL+25%RHA+6%LIME	37.48	1.311
100%SOIL+25%RHA+7%LIME	22.68	1.401
100%SOIL+25%RHA+8%LIME	21.03	1.421
100%SOIL+25%RHA+9%LIME	**20.65**	**1.432**
100%SOIL+25%RHA+10%LIME	19.96	1.412

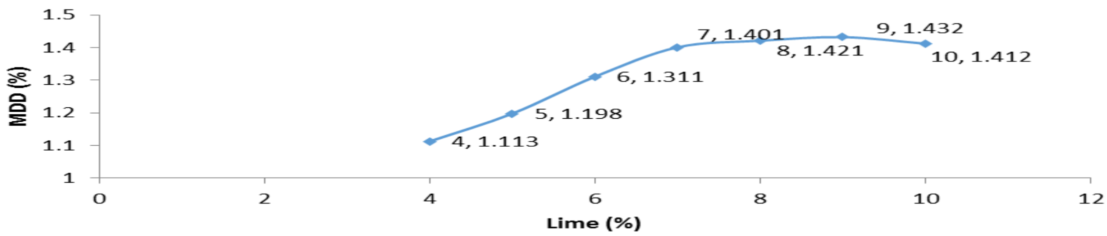

Fig3: Curve showing MDD values with %variation of Lime

Table4: Variation of CBR values of MC+RHA+ Lime

(75%MC+25%RHA+)	WATER CONTENT (%)	SOAKED CBR
4%LIME	38.3	3.126
5%LIME	39.48	3.136
6%LIME	37.48	4.256
7%LIME	22.68	5.384
8%LIME	21.03	6.136
9%LIME	**20.65**	**9.632**
10%LIME	19.96	6.272

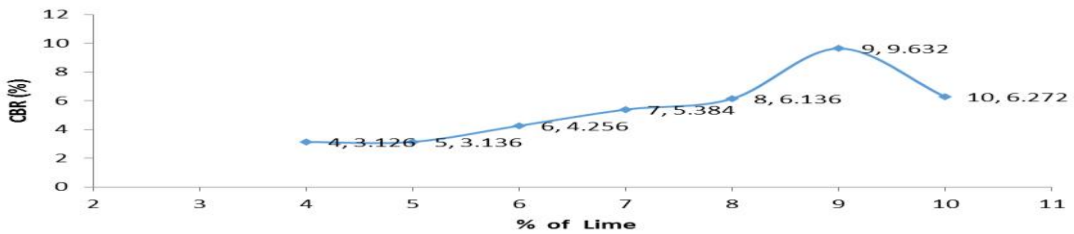

Fig4: Curve showing CBR values with % variation of lime

V. PLATE LOAD TEST RESULTS

LABORATORY CYCLIC PLATE LOAD TESTS ON UNTREATED AND TREATED MARINE CLAY SUBGRADE FLEXIBLE PAVEMENTS USING MODEL TANKS

Cyclic Plate Load Test

Plate Load Test is a field test for determining the ultimate load carrying capacity of soil and the maximum settlement under an applied load. The plate load test basically consists of loading a steel plate placed at the foundation level and recording the settlements corresponding to each load increment. The load applied is gradually increased till the plate starts to sink at a rapid rate. The total value of load on the plate in such a stage divided by the area of the steel plate gives the value of the ultimate bearing capacity of soil. The ultimate bearing capacity is divided by suitable factor of safety (which ranges from 2 to 3) to arrive at the value of safe load capacity of soil.

Cyclic plate load tests were carried out on untreated and treated marine clay flexible pavements in separate model tanks and the woven Geo-textile was used as reinforcement & separator between the treated marine clay subgrade & gravel sub-base and also between the sub base & the base course of model flexible pavement under pressures, viz 500kPa, 560kPa, 630kPa, 700kPa and 1000kPa. The tests were conducted until the failure of the marine clay model flexible pavements at OMC and FSC and the results were given in the Fig5 to Fig8 and Table5.

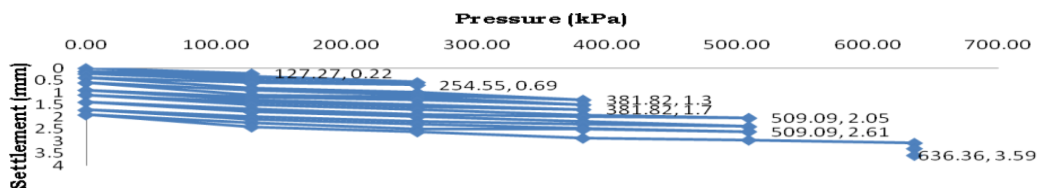

Fig.5 Laboratory Cyclic Plate Load Test results of Untreated Marine Clay Model Flexible Pavement at OMC

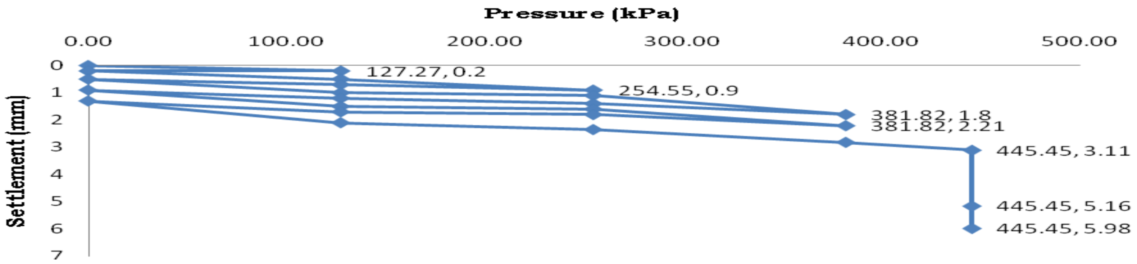

Fig.6 Laboratory Cyclic Plate Load Test results of Untreated Marine Clay Model Flexible Pavement at FSC

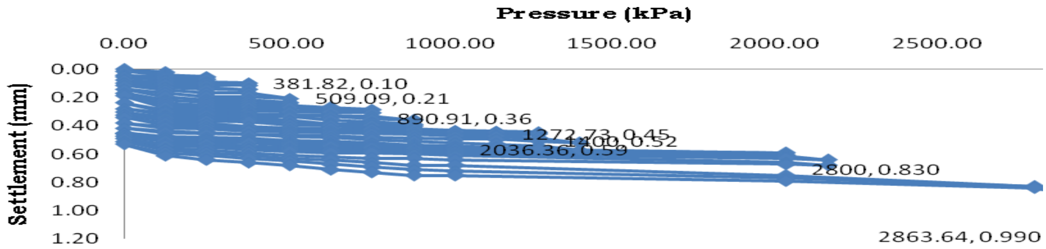

Fig7: Laboratory Cyclic Plate Load Test results of '25% RHA + 9% Lime+ Double Geo textile reinforced Maarine Clay Subgrade Model Flexible Pavement at OMC

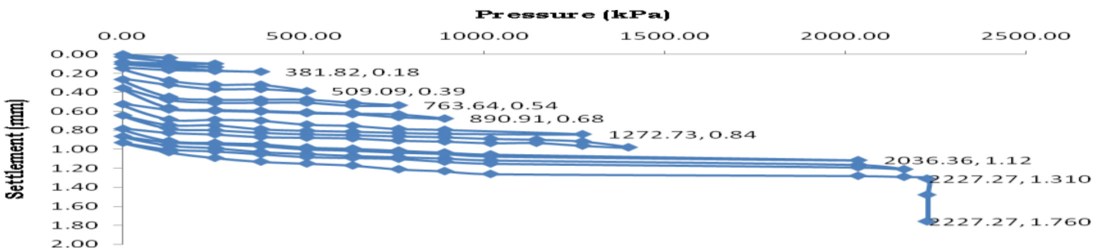

Fig8: Laboratory Cyclic Plate Load Test results of '25% RHA + 9% Lime+ Double Geo textile reinforced Marine Clay Subgrade Model Flexible Pavement at FSC

Table5: 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/M^2)		SETTLEMENTS (MM)	
				OMC	FSC	OMC	FSC
1	MARINE CLAY	----	------	63	31	2.75	4.71
2	MARINE CLAY + 15% 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	4%LIME+15% RHA + MARINE CLAY	GRAVEL	WBM-II	1300	900	1.6	2.05
5	4% LIME+ 15% RHA + MARINE CLAY AND GEO-TEXTILE PROVIDED AS REINFORCEMENT & SEPARATOR	GRAVEL	WBM-II	1800	1400	1.80	1.96
6	4% LIME+ 15% RHA + MARINE CLAY AND GEO-TEXTILE PROVIDED AS REINFORCEMENT & SEPARATOR	GRAVEL	WBM-II	2800	2200	0.83	1.21

VI. CONCLUSION

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 from 509kPa to 2800kPa at OMC and 381kPa to 2200kPa at FSC when compared with untreated marine clay model flexible pavement.

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