Experimental Investigation on Stabilizing Expansive Shedi Soil Using Rice Husk Ash and Lime Sludge

Karthik [1], Nadeem[1], Raghvendra[1], Gavisiddesh Majjagi[2]

BE Final Year Student[1], Assistant Professor [2]

Department of Civil Engineering, SDM Engineering College, Dharwad, Karnataka, India

***Abstract*—This work relates with usage of environmental hazardous waste of rice husk ash and lime sludge with expansive soil. The results showed appreciable increase in their strength value with the 7day period. The rice husk ash is a waste material obtained around Hyderabad Karnataka region after burning of rice husk,. Lime sludge is another waste material obtained from paper manufacturing industry. These materials have should be effectively used in engineering applications to avoid major environmental pollution issues. Hence usage of these material is recommended which are economical too.**

I. INTRODUCTION

Expansive soil is a difficult soil for construction because of its cyclic swell - shrink behaviour and low strength. These types of soils expand significantly coming in contact with water and shrink when water evaporates out, resulting severe damages to lightly loaded structures constructed on them. Stabilization using industrial wastes is one of the efficient, popular and cost effective techniques, out of several techniques of construction on expansive soils. Soil stabilization is a process by which certain materials are added to soil to improve its engineering properties. These materials may be classified as pozzolanic (fly ash, rice husk ash etc.), binder (lime, cement, cement kiln dust, lime sludge etc.) and inert (quarry dust, sand, ceramic dust etc.) are added to soil individually or combined.

Rice husk ash (RHA) is the ash produced by burning of rice husk. Silica is the main constituent of rice husk ash. It has been found to be pozzolanic material due to its high amorphous silica content Another waste produced from paper manufacturing industry is lime sludge the main constituent of which is lime.RHA as a pozzolanic material and lime sludge as a binder can be utilized to stabilize expansive soil.

RHA added to soil was in proportion of 8 to 12% of total weight of soil and lime sludge from 13 to 17% of total weight of soil. UCS of soil was studied for different proportions of stabilizing materials for a curing period of 7 and 21 days.

II. MATERIALS USED

2. Soil

Shedi soil is collected from Haliyal road of Dharwad city, Karnataka state with *Latitude* 15° 28' *N* and *Longitude* 75° 1' *E*. The obtained test results are carried out according to IS codes are exclusively given in the below Table respectively.

Properties	Shedi soil	IS Codes
Specific gravity, G	2.54	IS 2720 part III Sec-1, 1980
Atterberg Limits;		
Liquid limit, w_L (%)	49.4	IS 9256-1979
Plastic limit, w_P(%)	27.93	IS2720 partV, 1985
Plasticity index, I_P(%)	22.1	
Compaction characteristics;		
Field density,(kN/m^3)	15.31	IS2720 partVIII, 1983
Maximum dry density, γ_{dmax}(kN/m^3)	17.46	
Optimum moisture content, W_{OMC} (%)	18.20	
Grain size distribution;		
Gravel and sand (%)	40.84	IS 2720 part IV,1985
Silt & Clay (%)	59.14	
Unconfined compressive strength (kPa)	52.7	IS 2720 partX,1991
Unified classification	CI	
C, kg/cm^2	0.44	IS 3720
Friction angle (φ)	21°	part XI 1993

2a. Lime Sludge & Rice Husk Ash

It is produced from the paper manufacturing industry and the main constituent is lime. The chemical compositions of the lime sludge are: CaO-48%, SiO2 -6.54%, Al2O3 -1.15%, Fe2O3-1.2% etc.

RHA as a pozzolanic material and lime sludge as a binder can be utilized to stabilize expansive soil.

Rice husk ash (RHA) is the ash produced by burning of rice husk. Silica is the main constituent of rice husk ash. It has been found to be pozzolanic material due to its high amorphous silica content. The RHA used in the laboratory tests is a processed RHA, collected from a plant. The chemical compositions of RHA are: - SiO2 -91.6%, Al2O3 - 3.52%, Fe2O3-0.64 %, CaO -1.34 % etc. The specific gravity of the RHA is 2.3.

III. TESTING METHODOLOGY

UCS sample was prepared by taking dry sample of weight 140.5 gram and 33ml of water and tested for zero days. Then the materials, rice husk ash and lime sludge were added in the proportion to the dry weight of soil, as given the table 6.1. The samples were cured in the decicator and were tested for 7 day and 21 day strength.

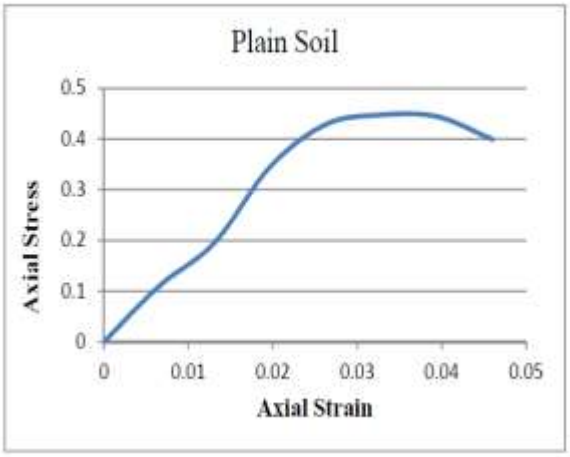
The materials were added in the proportion as shown in the table below.

Rice Husk Ash (%)	Lime Sludge (%)	Designation
8	13	A
10	15	B
12	17	C

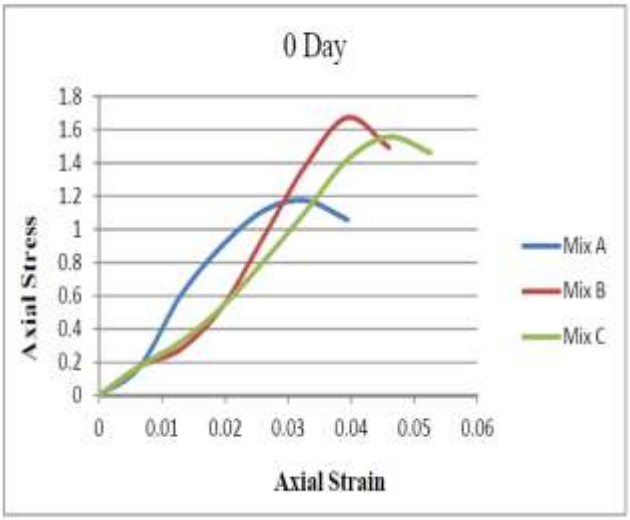
FIGURES SHOWING FAILURE MECHANISM OF SAMPLES

IV. RESULTS FOR ALL COMBINATIONS OF SOIL, RHA AND LIME SLUDGE FOR 7 AND 21 DAY UCS STRENGTH

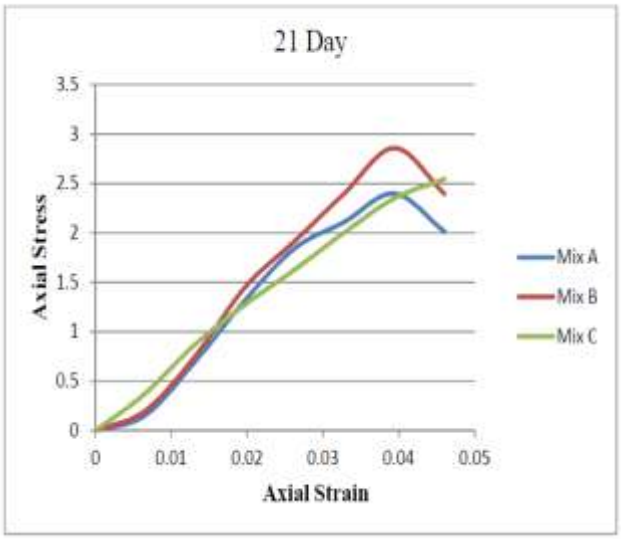
Analysis of Plain soil:



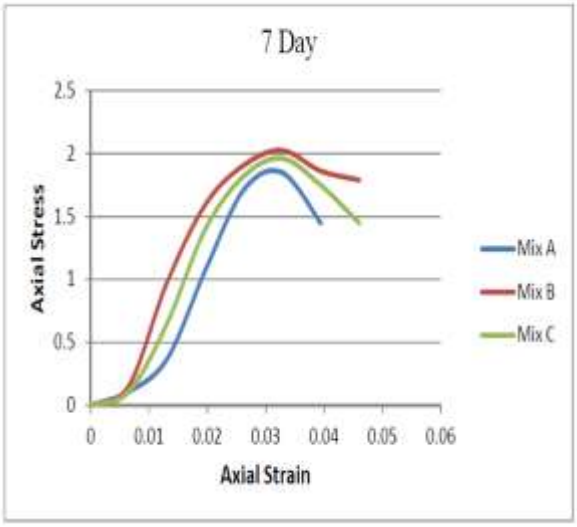
Analysis of mixes A, B and C at 0 day:



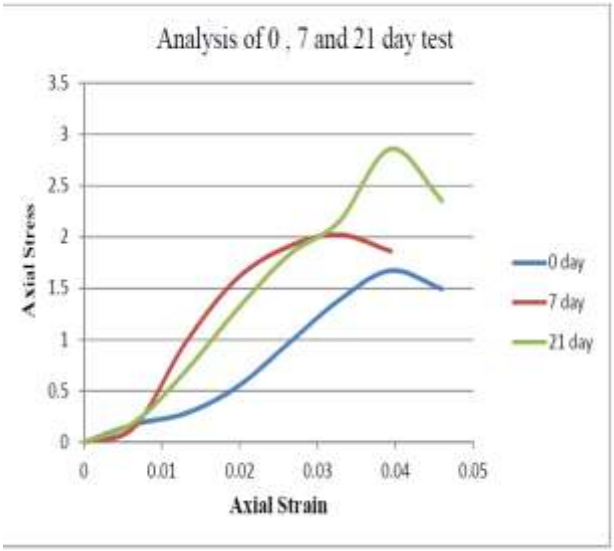
Analysis of mixes A, B and C at 21 day:



Analysis of mixes A, B and C at 7 day:



Analysis of 0 day, 7 day and 21 day test:



V. SUMMARY & DISCUSSION

a) Comparison of results for zero day strength:

RHA (%)	LS (%)	UCS Value
8	13	119.53 kN/m²
10	15	143.23 kN/m²
12	17	140.69 kN/m²

b) Comparison of results for seven day strength:

RHA (%)	LS (%)	UCS Value
8	13	182.26 kN/m²
10	15	198.17 kN/m²
12	17	174.44 kN/m²

c) Comparison of results for twenty one day strength:

RHA (%)	LS (%)	UCS Value
8	13	229.77 kN/m²
10	15	291.39 kN/m²
12	17	252.73 kN/m²

- *Mix A*

Table below shows the percentage increase in UCS value of mix A from 0 day to 21 day.

Serial no.	Curing Period	Increase in strength (%)
1.	0 to 7 days	52.48%
2.	0 to 21 days	92.22%
3.	7 to 21 days	26.06%

- *Mix B*

Table below shows the percentage increase in UCS value of mix B from 0 day to 21 day.

Serial no.	Curing Period	Increase in strength (%)
1.	0 to 7 days	38.35%
2.	0 to 21 days	103.44%
3.	7 to 21 days	47.04%

- *Mix C*

Table below shows the percentage increase in UCS value of mix C from 0 day to 21 day.

Serial no.	Curing Period	Increase in strength (%)
1.	0 to 7 days	20.56%
2.	0 to 21 days	74.42%
3.	7 to 21 days	44.88%

VI. CONCLUSION

1. The RHA and lime sludge can be used as soil stabilizing agents.
2. They don't have any biodegradable action.
3. From the study of the economy of stabilization, it is found that there can be substantial save in cost of construction of pavement if RHA and lime sludge is utilized in strengthening the sub-grade of flexible pavement. However, the benefits of economy and durability can be achieved if the sub-grade soil is stabilized at optimum percentage of RHA and lime sludge.

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AUTHORS

1) Karthik,Nadeem, Raghvendra were students of final year of bachelor of civil engineering from SDM Engineering college Dharwad

2) Gavisiddesh S Majjagi is working as assistant professor in SDM Engineering college Dharwad, he was worked in geotechnical field for 6years in industry and now 1.5years in academic field.