e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:06/Issue:11/November-2024 Impact Factor- 8.187 www.irjmets.com

STUDY ON BEHAVIOUR OF CLAYEY SOIL STABILIZED WITH RICE HUSK ASH AND LIME

TV Dinesh*1, Dr. Nagaraja Gupta MS*2

*1Student, Department Of Civil Engineering, East West Institute Of Technology, Bangalore, Karnataka, India.

*2Professor And HOD, Department Civil Engineering, East West Institute Of Technology, Bangalore, Karnataka, India.

DOI: https://www.doi.org/10.56726/IRJMETS64016

ABSTRACT

The majority of Indian soil is composed of clay, which makes building sub grades difficult. The lack of neighboring lands to allow for the excavation of fill material for the purpose of creating sub grade and the rise in road construction activities have resulted in a recent surge in the demand for sub grade materials. In this case, using the various alternative waste products that are generated which not only present environmental risks but also depositional issues is one way to solve the issue. Keeping this in mind, it may be possible to significantly reduce construction costs by stabilizing weak soil in place with the right admixtures. Due to this, the current study has been conducted using debris from agricultural sector like Rice Husk Ash, which has been combined with soil to examine how to improve the compaction and strength characteristics of weak sub grades. Research on silica derived from rice husk ashes as a pozzolanic material for soil stabilization has been fruitful. However, because the materials doesn't have the element of calcium, rice husk material cannot be employed exclusively. Therefore, in order to produce a visible chemical reaction during the stabilization process, husk ash must be combined with various cementation ingredients like lime. Calcium hydroxide or oxide is lime. CaO a naturally occurring mineral that is produced by coal fire and changed lime stones that are ejected by **volcanoes**. This study investigates the differences in features like as elasticity, permeability, and compressive strength between lime and RHA combined in varying percentages.

Keywords: Rice Husk Ash, Lime, Soil Stabilization,

I. INTRODUCTION

In general, expansive soils will expand when exposed to moisture and contract when that moisture is removed. Numerous issues with constructions built on top of or in touch with swelling soils are caused by these variations in volume. Any nation's ability to develop is reliant on its construction and transportation infrastructure. Improved soil qualities are necessary for the foundation beds' strength, which is necessary for the projects to succeed. Soil stabilization or alteration has the potential to amplify qualities of soil. In most cases, stabilization, alteration, or both can be used for improve soil.

Therefore soil stabilization refers to the process of treating soils to increase their durability and strength to the point where they are completely suitable for constructing above of their original classification, soil modification refers to the more addition of a modifier (such as cement, lime, etc.) to a soil in order to change its index properties.

The process of stabilization entails changing a soil's characteristics to enhance its engineering performance. The primary goals of stabilization in construction roads and airfields are to improve soil strength or stability and lower construction costs by maximizing the use of materials.

PURPOSE OF SOIL STABILIZATION

The purpose of soil stabilization is to:

- Increase the hilly soil's strength
- Reduce the expense of that strength-building.
- To use lesser quality materials that are readily available locally.
- To improve load-bearing capacity and aid in compaction.
- To lessen compressibility, which will lead to settlement.

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:06/Issue:11/November-2024 Impact Factor- 8.187 www.irjmets.com

- To enhance some of the unfavorable characteristics of soils, like extreme plasticity, excessive swelling or shrinkage, and compaction difficulties.

OBJECTIVES OF SOIL STABILIZATION:

This study's primary goal is to,

1. Enhance the site's land qualities and make it capable of supporting a load in order to boost shear strength by adding admixtures.
2. Lowering the soil's excess water content, air void by changing its compressibility, permeability, and shrinkage cracks.
3. By binding soil fragments shared, water-proofing the particles, or doing both at once,
4. Soil stabilization attempts to increase soil strength and resistance to water-induced relaxation.
5. Compression and drainage are the most basic stabilizing techniques; when water leaves moist soil, the soil gets stronger. The other method involves enhancing the size of the particles gradation, and poor soils can benefit even more from the use of binders.

SOIL STABILIZATION'S ADVANTAGES:

The standard procedure is to replace any weak soil with another good-quality soil if a weak soil strata is discovered during the building phase. By using a technique called soil stabilization, the site's locally accessible soil can be improved and used more productively without having to be replaced. Creating the sub grade by strengthening the readily accessible soil using various stabilization procedures is less expensive than preparing the sub grade by replacing the weak soil with a good quality soil. Through stabilization, the soil's strength-giving properties can be efficiently boosted to the necessary level. It increases the soil's bearing capacity by strengthening the soil. In comparison to deep foundation or raft foundation, increasing the soil's bearing capacity is more cost- and energy-effective. In slopes and other similar areas, it's also utilized to provide the soil more stability. In certain cases, soil stabilization is also utilized to stop dust from forming or soil erosion, which is particularly helpful in dry, arid weather. Water-proofing the strata of soil is another use for stabilization; by keeping water out of the soil strata, it keeps the soil from weakening. It lessens the amount that the soil changes in volume as a result of variations in moisture content or temperature. Nevertheless, there are drawbacks to soil stabilization, such as higher building costs and challenges incorporating the fibers into the soil.

SOIL STABILIZATION METHODS:

Here the well known methods to stabilize the soil to improvise its characteristics are being discussed,

Chemical stabilization and Mechanical stabilization

CHEMICAL SOIL STABILIZATION

Admixtures are included for chemical stabilization to change its characteristics of the soil sample. Extensive research has demonstrated approximately eighteen distinct chemical mechanisms, including: anon-cation exchange, adsorption, fixation, formation of new minerals, cementation, salt conversion, adsorption, modification of water films, enrichment of pore water with ions, alteration of capillary forces, alteration of the electrical surface tension of clay minerals, alteration of the electrical forces between particles, alteration of chemically bound water, adsorption of chemically bound water, neutralization of acids, neutralization of bases, and proton exchange. Expected results can be reached by laboratory testing; chemical additives are often added in tiny amounts to efficiently produce stabilization; the chemical process is not time-consuming; and effectiveness is achieved irrespective of the type of soil engineering properties are the notable benefits of chemical admixture stabilization.

MECHANICAL SOIL STABILIZATION

Physical processes are used in mechanical stabilization. It is the alteration of soil porosity and, for example, compaction-induced interlock or friction between particles. Contrast to chemical stabilization, it solely modifies the properties of the soil by blending it, creating a barrier to the soil, or adding fibrous, non-biodegradable reinforcement. Soil compaction, as used in geotechnical engineering, is the process of applying pressure to soils using large machinery. It induces densification in the soil by displacing air from the pores. The addition of various material grades to produce a densely compacted material and a limited amount of fine particles as binders for sand like non-cohesive soils to increase the material's strength are both of the mechanical stabilization process. Strongly angular sands and gravels give the mixture internal friction and incompressibility, which, when combined with an appropriate binder loading, results in stability.

TESTS PERFORMED

Following mentioned tests are conducted mainly to determine the various characteristics of the obtained soil sample,

1) Specific Gravity Test
2) Natural moisture content Test
3) Free Swell Test
4) Liquid limit Test
5) Standard Proctor Compaction Test
6) UCC- Unconfined compression strength test
7) Direct Shear Test

II. LITERATURE REVIEW

Brief Summary of Literature:

Azlan abdul aziz(1993):

The influence on certain geotechnical features of road building of different ratios of rice husk ash to cement. The effects of varying cement and RHA mix proportions on durability, tensile strength, soaked and un soaked unconfined compressive strength, and compaction parameters were investigated. According to test results, soil stabilized with cement and rice husk ash mixtures have a noticeable increase in strength, making them suitable for use on rural roads. The author further mentions that the compressibility and compressive strength of the soil sample compared to its original state it has increased optimistically by adding of cement and mid increase in compressive strength has been observed with the addition of rice husk with addition of proper amount of water, further enough amount of compaction and excess air void removal is required to meet the desired characteristics in the soil. It is clear that this method of stabilization might not be suitable for small scale building construction rather for high rise buildings it is recommended.

Agus Setyo Muntohar(2005):

There are expansive soils all around the world, as documented in many different nations. Wide-ranging soils pose an issue, especially in areas with dry and semi-arid climates. The field of geotechnical engineering has long understood that expanding soils can cause significant disruption and, as a result, serious harm to structures above them, especially low-rise buildings, highways, and underground lifelines. Stabilization can lessen the negative consequences of expanding soils. Soil stabilization may involve a range of treatment, which modifies soils to meet specific engineering requirement and weather resistance. Finding ways for the utilization of wastes would be an advantageous as they can be freely available at minimal costs. The potential secondary stabilizing agents are, Ex: rice husk ash, pulverized fuel ash (PFA), and granulated-ground blast-furnace slag (GGBS). These materials can be grouped as secondary stabilizing agents that are not very effective on their own but can be usefully used in conjunction with lime or cement.

Ario Muhammad (2007):

Research on silica derived from rice husk ashes as a pozzolanic material for soil stabilization has been fruitful. However, because the materials does not have the element of calcium, rice husk cannot be employed exclusively. Therefore, in order to create a proper chemical chain reaction during the stabilization process, rice husk must be combined with other cementation ingredients like lime and cement. This study's primary goal was to determine the stabilized clayey sub grade's bearing capability using fibers and ash from rice husks. Compaction and CBR testing will be the primary laboratory tests. The findings of the experiment showed that adding lime-rice husk ash-fiber to the soil reduced OMC and MDD. However, stabilization and strengthening using fiber waste and lime-rice husk ash greatly enhanced the obtained values.

Musa Alhassan(2008):

The soil-RHA's performance was examined using compaction characteristics, California bearing ratio, and unconfined compressive strength test. A soil sample collected from the Maikunkele area of Minna and they are stabilized with addition of 2-12% rice husk ash by equal weight of dry soil. The findings that were obtained show a general decrease in maximum dry density and an increase in the ideal amount of moisture (OMC) with increasing RHA content. The CBR and UCS improved slightly as the RHA content increased. Peak UCS values have been detected between 6-8% RHA, showing that 6-8% RHA has little potential for strength enhancement.

T. K. Roy(2008):

We can see the rising demand for the need for sub-grade materials due to rise in construction activities of highway road sectors due to less availability of raw materials nearby the work area. In this case, one solution is to use the various alternative created waste materials, which cause environmental hazards and depositional problems. Using this perspective, he author have investigated the improvement of the qualities of alluvial soil mixed with a large amount of pond ash, rice ash, and a small quantity of cement. Experimental results showed increases in index qualities and likewise a considerable increase in the soaked California bearing ratio value of the soil which is mixed containing alluvial soil strata, pond ash, and rice ash, have observed to be amplifying the characteristic than the original one.

Chakraborty and Saibal (2010):

The high demand of construction activities over the area of road sector, the natural need for sustainable road materials has increased. The lack of surrounding land for allowing the excavation of materials for sub-grade construction has exacerbated the problem. Remembering this fact, stabilizing poor soil in situ with appropriate admixtures can significantly reduce construction costs. The authors have conducted the study using waste materials from paddy cultivation such as rice husk ash mixed with soil or a lime-soil mixture to investigate the improvement of poor sub grades when it comes to compaction and strength properties. The lab test findings demonstrate a significant improvement in soil strength by mixing of variety of admixtures and test conduction of California Bearing Ratio. It is found out by the author after thee final of the experiment that after seven days of curing with the combination of lime and rice hush at the quantity of 6% and 10% will yield an accountable improvement in bearing capacity and compressive strength based tests.

Nadgouda K.A.(2010):

Expansive and cohesive soils like black soil exhibit significant swelling and shrinking when exposed to variations in moisture content, and so have been identified as the most problematic from an engineering standpoint. Stabilization happens when lime is introduced to black cotton soil, causing a pozzolanic reaction. The hydrated lime combines with the clay particles, irreversibly transforming them into a strong cementing matrix. Cotton soil with less to medium swelling potential was employed to determine the soil's basic qualities. Alteration in various soil values such as moisture content, free swell, max.dry density, swelling pressure, plastic

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:06/Issue:11/November-2024 Impact Factor- 8.187 www.irjmets.com

limit and California bearing ratio, were investigated. The bearing ratio value is at its highest when 3.5% to 4.5% lime is added, and it declines thereafter.

Abu Siddique (2011):

The lime stabilization effects on the plasticity, moisture-density, shrinkage, stiffness, swelling, and other properties of an expansive soil have been studied. The soil was stabilized by the use of lime concentrations of 3%, 6%, 9%, 12%, and 15%. The plasticity index, volumetric shrinkage, shrinkage ratio, and linear shrinkage of treated soil all decreased significantly as the lime level increased. The free swell and free swell index of stabilized samples drop dramatically as lime content increases.

The swelling pressure, swelling potential, and volume change of treated samples all decrease significantly as the lime percentage increases. As the lime rose, maximum dry density fell but optimal moisture content increased. The California Bearing Raito (CBR) of the stabilized samples at all degrees of compaction rose significantly with increasing lime concentration and curing time.

Pooja Upadhyay (2016):

- Fiber reinforcement of 0.5%, 1.0%, and 1.5% increased soil cohesion by 10%, 4.8%, and 3.73%, respectively, resulting in 0.8%, 0.31%, and 0.47% increases in interior angle of friction (φ). Since the internet, the values of c and φ have increased by 19.6%, from 0.325 kg/cm2 to 0.3887 kg/cm2, and 1.59%, with an angle of friction ranging from 47.720 to 48.4830. It is frequently determined that using randomly distributed Coir fiber reinforcement for that type of soil is not advised.
- The shear strength properties of soil sample 2 measured by direct shear strength test show , fiber reinforcement of 0.5%, 1.0%, and 1.5% increases the value for cohesion by 34.7%, 6.09%, and 7.07%, respectively. The rise in interior angle of friction (φ) was determined to be 0.8%, 0.31%, and 0.47%. The net increase in c and φ values was 53%, from 0.3513 kg/cm2 to 0.5375 kg/cm2, and 15.02%, with an angle of friction ranging from 27.820 to 320 degrees. Coir fiber can be used to strengthen soils, as demonstrated by the soil sample. Therefore, it is commonly stated that strengthening soil with fibers is a virtually equivalent ground improvement approach, particularly in engineering projects on weak soils where it can operate as a substitute for deep/raft foundations, lowering project value.

III. MATERIALS AND METHODOLOGY

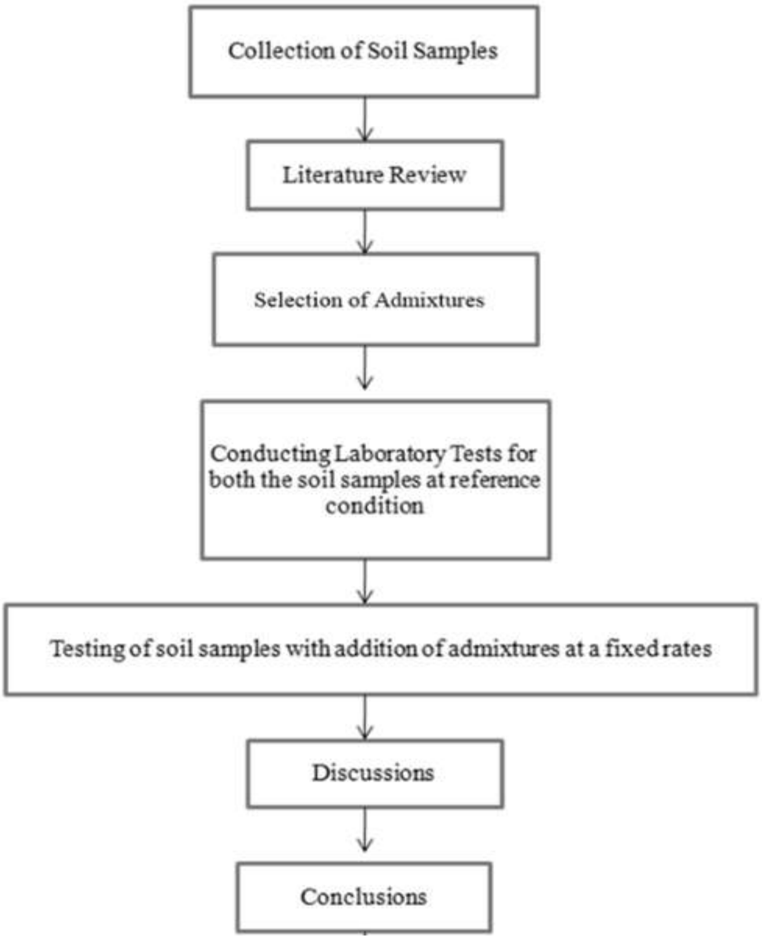
Rice Husk Ash

Rice husk ash, which is essentially a debris, by product material, is produced by the rice factory during processing of rice taken from paddy plants. This type of ash is a pozzolanic type material that can be used as an admixture for stabilization purposes. However, minimally manufactured and available widely. Paddy generates approximately 20-22% rice husk, with approximately 25% total husk becoming ash being burned. It is non-plastic in nature. This particular substance has a good pozzolanic properties.

Lime

Lime is a term used to describe calcium-containing inorganic compounds that are mostly carbonates, oxides, and hydroxides. Lime is technically known as calcium hydroxide. It is the name of the natural mineral (native lime) CaO, which occurs due to eruption coal seam fires and in changed lime stones during volcanic eruption. The word "lime" comes from its early use as a building mortar and means "sticking and or adhering".

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:06/Issue:11/November-2024 Impact Factor- 8.187 www.irjmets.com



IV. EXPERIMENTAL WORK

In this project we have conducted the following tests for both the original clay soil and mixed with rice husk and Lime (each separately) to identify the characteristics of soil, Treating the soil with the tests mentioned below:

Specific Gravity test: **(IS 2720: Part 3/Sec-2: 1980)**

Natural Moisture Content test: **(IS 2720: Part 2: 1973)**

Free Swell index: **(IS 2720: Part 40: 1977)**

Liquid Limit Test: **(IS 2720: Part 5: 1985)**

Standard Proctor Compaction Test: **(IS 2720: Part 3: Sec 1: 1980)**

UCC- Unconfined Compression Test: **(IS 2720: Part 10: 1991)**

Direct Shear Strength Test: **(IS 2720: Part 13: 1986)**

V. RESULTS AND DISCUSSION

Specific gravity of soil sample

1	Weight of Sp Gr Bottle (W_1), in g		31.00
2	Sp Gr Bottle Weight + Dry Soil Weight (W_2), in g		51.00
3	Sp Gr Bottle Weight + Dry Soil + Water Weight (W_3), in g		92.80
4	Sp Gr Bottle Weight + Water Weight (W_4), in g		80.50
5	Weight of Oven Dry Soil (W_2-W_1) (W_S), in g		20.00
	Sp. Gr (G) =	$\frac{W_S}{(W_4 + W_S)-W_3}$	**2.60**

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:06/Issue:11/November-2024 Impact Factor- 8.187 www.irjmets.com

Original soil sample

Bore Hole No 2
Depth 2.00 m

$$w = \frac{W2-W3}{W3-W1}$$

Cointainer No.	=	25
Cointainer Weight	=	16.70
Wet soil weight	=	39.70
Dry soil weight	=	32.80
W1 = Mass of container with lid in g	=	16.70
W2 = Mass of container with lid with wet soil in g	=	56.40
W3 = Mass of container with lid with dry soil in g	=	49.50

$$w = \frac{W2-W3}{W3-W1} = \frac{6.90}{32.80} = 21.04\%$$

Soil sample mixed with 10% of Rice Husk Ash

Bore Hole No 2
Depth 2.00 m

$$w = \frac{W2-W3}{W3-W1}$$

Cointainer No.	=	16
Cointainer Weight	=	16.40
Wet soil weight	=	38.10
Dry soil weight	=	30.20
W1 = Mass of container with lid in g	=	16.40
W2 = Mass of container with lid with wet soil in g	=	54.50
W3 = Mass of container with lid with dry soil in g	=	46.60

$$w = \frac{W2-W3}{W3-W1} = \frac{7.90}{30.20} = 26.16\%$$

Soil sample mixed with 20% of Rice Husk Ash

Bore Hole No 2
Depth 2.00 m

$$w = \frac{W2-W3}{W3-W1}$$

Cointainer No.	=	60
Cointainer Weight	=	16.40
Wet soil weight	=	38.60
Dry soil weight	=	29.60
W1 = Mass of container with lid in g	=	16.40
W2 = Mass of container with lid with wet soil in g	=	55.00
W3 = Mass of container with lid with dry soil in g	=	46.00

$$w = \frac{W2-W3}{W3-W1} = \frac{9.00}{29.60} = 30.41\%$$

Soil sample mixed with 2% of lime

Bore Hole No 2
Depth 2.00 m

$$w = \frac{W2-W3}{W3-W1}$$

Cointainer No.	=	69
Cointainer Weight	=	15.50
Wet soil weight	=	36.70
Dry soil weight	=	31.10
W1 = Mass of container with lid in g	=	15.50
W2 = Mass of container with lid with wet soil in g	=	52.20
W3 = Mass of container with lid with dry soil in g	=	46.60

$$w = \frac{W2-W3}{W3-W1} = \frac{5.60}{31.10} = 18.01\%$$

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:06/Issue:11/November-2024 Impact Factor- 8.187 www.irjmets.com

Soil sample mixed with 4% of lime

Bore Hole No 2
Depth 2.00 m

$$w = \frac{W2-W3}{W3-W1}$$

Cointainer No.	=	100
Cointainer Weight	=	15.20
Wet soil weight	=	36.80
Dry soil weight	=	31.70

W1	=	Mass of container with lid in g	=	15.20
W2	=	Mass of container with lid with wet soil in g	=	52.00
W3	=	Mass of container with lid with dry soil in g	=	46.90

$$w = \frac{W2-W3}{W3-W1} = \frac{5.10}{31.70} = 16.09\%$$

LIQUID LIMIT TEST AND PLASTIC LIMIT:

1) Soil sample in its original state,

No. of Blows	Container No.	Weight of Container + Wet soil, g	Weight of Container + Dry soil, g	Weight of Container	Moisutre Content (%)
35	1(TU)	36.50	30.00	12.50	37.14
24	2(BJ)	37.20	29.66	12.20	43.18
16	4(CD)	35.70	27.80	12.60	51.97
PL	7	25.60	23.20	12.50	**22.43**

2) Soil sample mixed with 10% of Rice hush ash,

No. of Blows	Container No.	Weight of Container + Wet soil, g	Weight of Container + Dry soil, g	Weight of Container	Moisutre Content (%)
37	30	36.10	28.20	9.60	42.47
25	35	35.20	26.00	9.20	54.76
14	40	35.60	25.40	9.70	64.97
PL	41	23.60	20.00	9.60	**34.62**

3) Soil sample mixed with 20% of Rice hush ash,

No. of Blows	Container No.	Weight of Container + Wet soil, g	Weight of Container + Dry soil, g	Weight of Container	Moisutre Content (%)
36	O	35.80	28.20	12.50	48.41
26	FM	35.00	26.70	12.50	58.45
15	88	34.20	25.20	12.70	72.00
PL	48	26.60	22.60	13.10	**42.11**

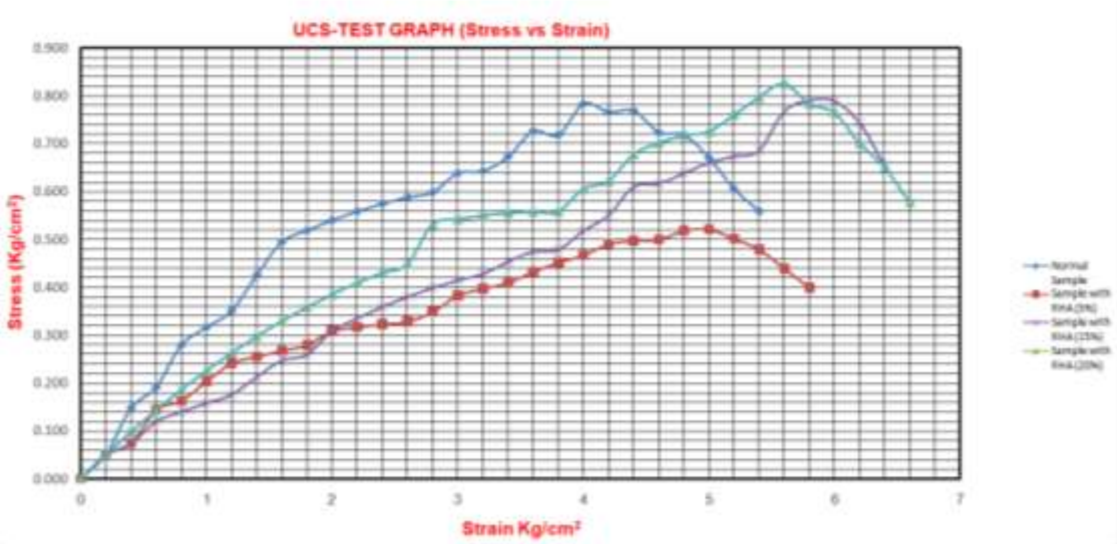
4) Soil sample mixed with 2% of lime

No. of Blows	Container No.	Weight of Container + Wet soil, g	Weight of Container + Dry soil, g	Weight of Container	Moisutre Content (%)
34	1(TU)	35.70	29.70	12.50	34.88
25	4(CD)	36.00	29.40	12.60	39.29
14	7	35.30	28.10	12.50	46.15
PL	2(BJ)	24.00	21.70	12.20	**24.21**

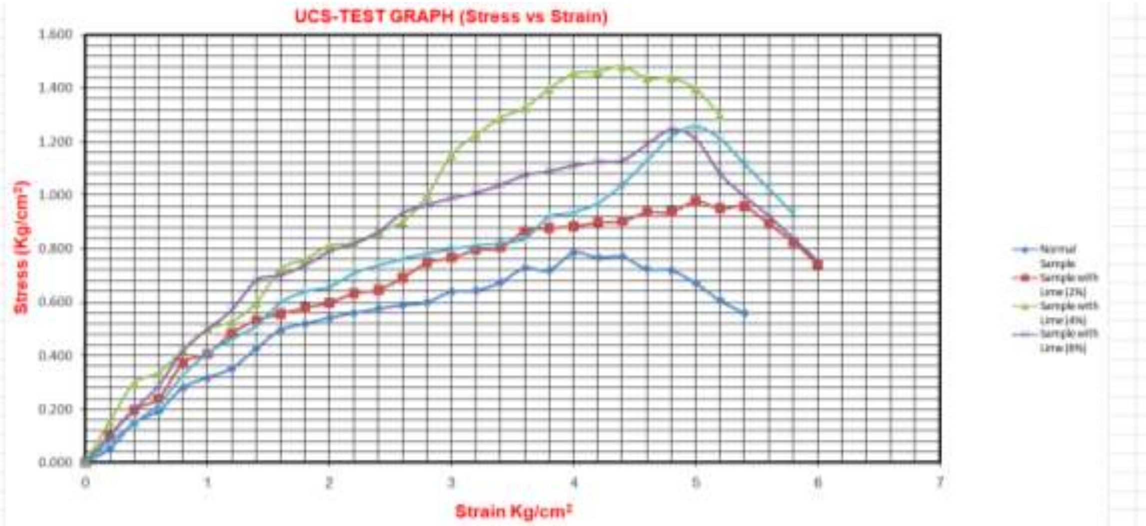
5) Soil sample mixed with 6% of lime,

No. of Blows	Container No.	Weight of Container + Wet soil, g	Weight of Container + Dry soil, g	Weight of Container	Moisutre Content (%)
37	30	35.90	30.60	9.60	25.24
26	35	34.60	28.70	9.20	30.26
15	40	33.70	27.40	9.70	35.59
PL	41	23.50	20.60	9.60	**26.36**

Here we compare the graph results of UCC test done for original soil ample with the mixed sample,



(A Comparison of soil sample in original state and soil sample mixed with rice husk ash)



(A Comparison of soil sample in original state and soil sample mixed with Lime)

FREE SWELL INDEX:

After conducting the index test we noticed, that the normal soil sample has got a free swell up to 12% and for the normal sample with partial replacement with lime and rice husk (separately) the value is found out to be 18%.

OBSERVATION AND CALCULATION:

NORMAL SOIL SAMPLE

For Normal water 10ml of soil swelled up to 16ml & for kerosene 10ml of soil swelled up to 11ml

Free swell index = [(16-11)/11]×100= 45%

NORMAL SOIL SAMPLE WITH 10% RICE HUSK ASH

For Normal water 10ml of soil swelled up to 14.50ml & for kerosene 10ml of soil swelled up to 10.50ml

Free swell index = [(14.50-10.50)/22]×100= 38%

NORMAL SOIL SAMPLE WITH 20% RICE HUSK ASH

For Normal water 10ml of soil swelled up to 13.50ml & for kerosene 10ml of soil swelled up to 10ml

Free swell index = [(13.50-10)/10]×100= 35%

NORMAL SOIL SAMPLE WITH 2% LIME

For Normal water 10ml of soil swelled up to 14ml & for kerosene 10ml of soil swelled up to 10ml

Free swell index = [(14-10)/10]×100= 40%

NORMAL SOIL SAMPLE WITH 4% LIME

For Normal water 10ml of soil swelled up to 13ml & for kerosene 10ml of soil swelled up to 9.50ml

Free swell index = [(13-9.50)/9.50]×100= 37%

STANDARD PROCTOR TEST:

1) Test results for soil sample in original state

Sample	Weight of the mould + wet soil	Weight of wet soil	Wet density	Weight of wet soil in container	Weight of dry soil in cont	Water content	Dry density
	G	G	g/cc	G	g	%	g/cc
I	6136	1872	1.872	28	22	33.3	1.37
Ii	6197	1933	1.933	32	26	33.3	1.54
Iii	6316	2097	2.097	42	32	35.71	1.68
Iv	6316	2178	2.178	34	29	20.4	1.61
V	6285	2021	2.021	27	24	15.0	1.52

2) Test results for soil sample mixed with Lime

Sample	Weight of the mould + wet soil	Weight of wet soil	Wet density	Weight of wet soil in container	Weight of dry soil in cont	Water content	Dry density
	G	G	g/cc	G	g	%	g/cc
I	6246	1972	1.972	34	28	17.6	1.67
Ii	6324	2060	2.060	40	32	20	1.71
iii	6254	1990	1.990	32	24	25	1.59
iv	6244	1980	1.980	38	27	28.9	1.53
v	6266	2002	2.002	44	30	31.8	1.51

3) Test results for soil sample mixed with Rice husk ash

Sample	Weight of the mould + wet soil	Weight of wet soil	Wet density	Weight of wet soil in container	Weight of dry soil in cont	Water content	Dry density
	G	G	g/cc	G	g	%	g/cc
i	6266	2002	2.002	40	34	15	1.74
ii	6334	2070	2.070	40	32	20	1.72
iii	6302	2038	2.038	36	28	22.2	1.67
iv	6388	2124	2.124	37	28	24.3	1.70
v	6314	2050	2.050	35	26	25.7	1.63

DIRECT SHEAR TEST:

1) Result for Normal Soil Sample

Weights	Trial1	Trial2	Trial3
0.5Kg	0.38Kg/cm2	0.34Kg/cm2	0.41Kg/cm2
1.0Kg	0.46Kg/cm2	0.43Kg/cm2	0.46Kg/cm2
1.5Kg	0.43Kg/cm2	0.46Kg/cm2	0.50Kg/cm2

2) Result for Soil Sample with Partial Replacement of Rice Hush Ash (upto 10%)

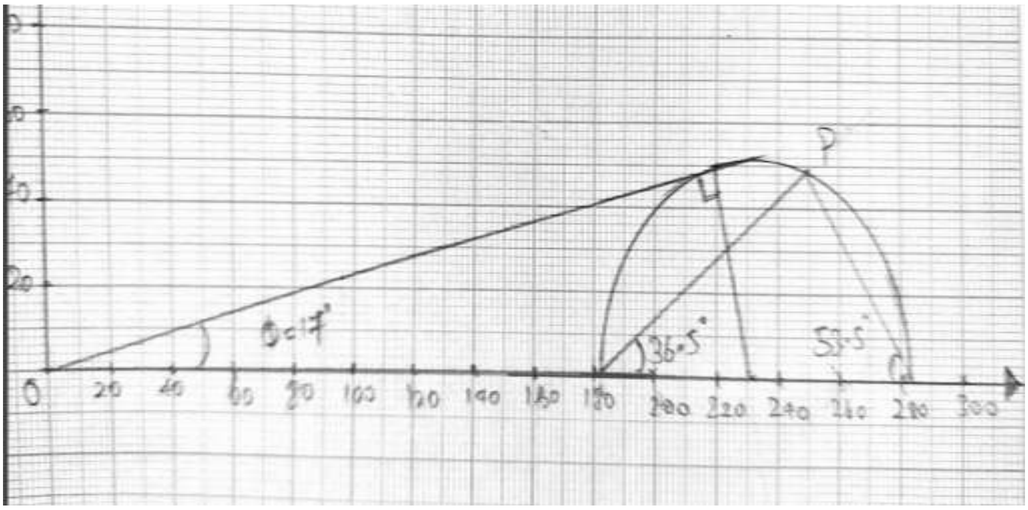
Weights	Trial1	Trial2	Trial3
0.5Kg	0.67Kg/cm2	0.68Kg/cm2	0.66Kg/cm2
1.0Kg	0.85Kg/cm2	0.85Kg/cm2	0.87Kg/cm2
1.5Kg	1.01Kg/cm2	1.04Kg/cm2	1.02Kg/cm2

3) Result for Soil Sample with Partial Replacement of Lime (up to 10%)

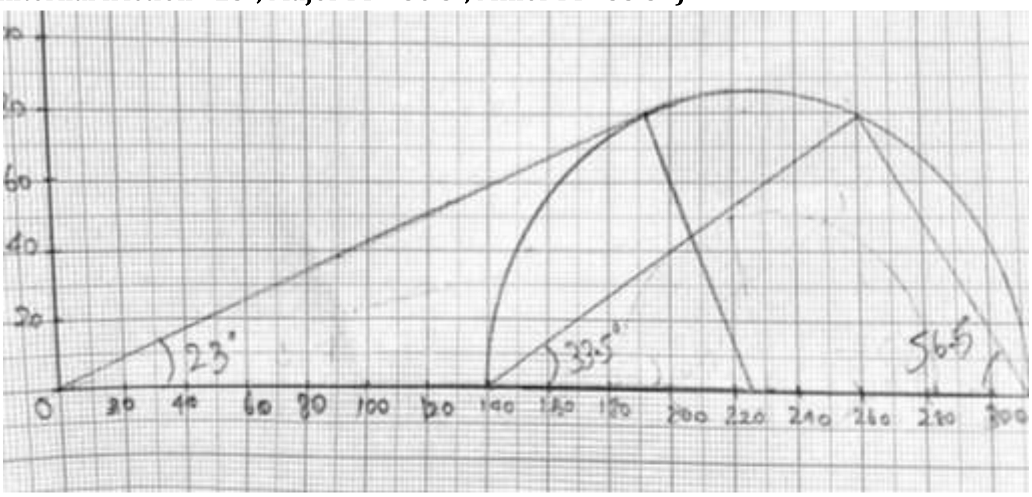
Weights	Trial1	Trial2	Trial3
0.5Kg	0.52Kg/cm2	0.57Kg/cm2	0.58Kg/cm2
1.0Kg	0.76Kg/cm2	0.73Kg/cm2	0.78Kg/cm2
1.5Kg	1.04Kg/cm2	1.07Kg/cm2	1.05Kg/cm2

MOHR'S CIRCLE

1) Mohr's circle for ordinary sample (Angle of internal friction= 17°, Major PP= 53.5°, Minor PP=36.5°)

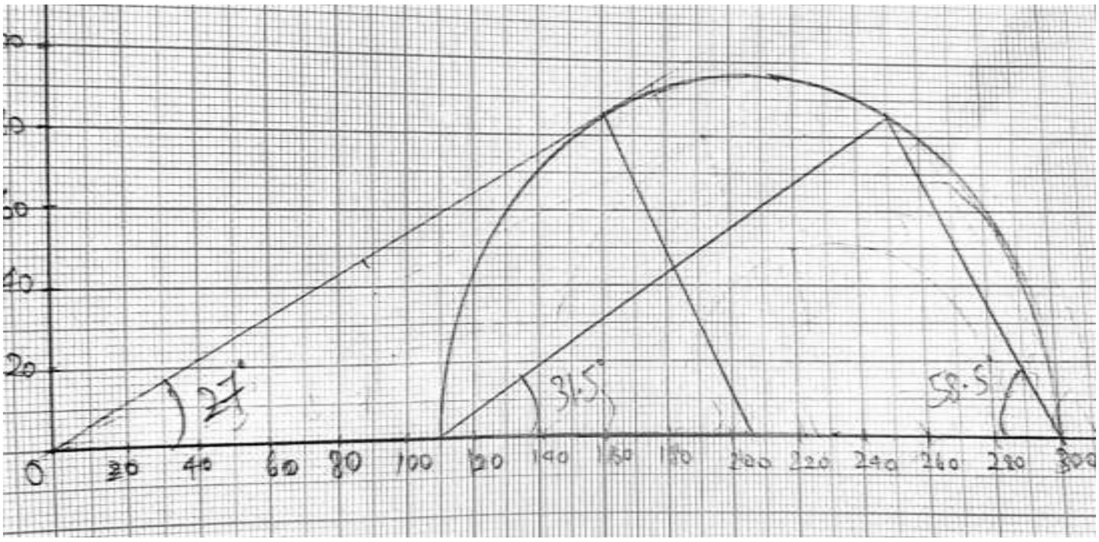


2) Mohr's circle for sample with replacement of Rice Hush Ash
(Angle of internal friction= 23°, Major PP= 56.5°, Minor PP=33.5°)



e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:06/Issue:11/November-2024 Impact Factor- 8.187 www.irjmets.com

3. Mohr's circle for sample with replacement of Lime
(Angle of internal friction= 27°, Major PP= 58.5°, Minor PP=31.5°)



From the above results we come to conclude the following points

1. The average liquid limit of original soil was found out to be 43.18% whereas partially mixed with lime 30% to 39.9% and with rice husk ash it increases up to 54% to 58% . the percentage in the reduction of liquid limit is observed with lime admixture.
2. Based on the standard proctor compaction test it was found to be 1.68g/cc for the normal soil whereas for partially replaced lime be 1.70g/cc and in Rice husk ash its 1.71g/cc. It is observed that the water content is reduced slightly and enhances the compacting capability.
3. 3.Soil sample's shear strength that is based on the unconfined compression test was found to be 0.783 kg/cm2 and with mixing of rice husk ash and lime separately, we get 0.827 kg/cm2 & 1.48 kg/cm2 . It is noted that the shear strength is enhanced with the mix of these admixtures.
4. 4.The swelling of the normal soil was found to be 45% whereas with mixture of lime and rice hush ash it is reduced up to 35% and 37%.
5. 5.The maximum shear stress at failure was 0.50 Kg/cm2. On addition of 10% of Rice husk ash & Lime to the soil sample its properties has been increased. The maximum shear stress in failure rose to 1.02 Kg/cm2 & 1.05 Kg/cm2

VI. CONCLUSION

- Compared to liquid limit of original soil sample with lime reduces the liquid limit value and rice husk rise up partially.
- From standard proctor compaction test it was found,
- Addition of these two admixtures separately, dry density had rise up very less compared to the original sample's value.
- It is noted that the shear strength in compression strength test is enhanced optimistically with the mix of these admixtures.
- Swelling index of admixture mixed samples has descended compared to normal sample's swelling percentage.
- Increase in max. shear stress at failure has rose up by adding of admixtures and has helped in providing more shear stress.

From the above points we can conclude that partially replacing the soil by mixing of rice husk ash and lime as admixture is noted to be enhancing the characteristics like bearing capacity and kerosene oil, compressibility and reducing the swelling of soil compared to its original state.

VII. REFERENCES

[1] Ahmed M. Gamal, Adel M. Belal, S. A. Elsoud (2016): “Numerical Modeling of Geogrid Reinforced Soil Bed under Strip Footings using Finite Element Analysis” World Academy of Science, Engineering and Technology, International Journal of Civil and Environmental Engineering, Vol:10, No:1, 2016.

[2] Azlan Abdul Aziz. (1993), 'Effect of Cement-Rice Husk Ash on Compaction, Strength and Durability of Melaka series Latertic Soils', The professional journal of the institution of surveyors Malaysia volume 28 no 6 3 quarterly pp7 35/3/93 ISSN 0127- 4937.

[3] Abu Siddique (2011), 'Effects of Lime Stabilisation on Engineering Properties Of An Expansive Soil For Use In Road Construction', Journal of Society for Transportation and Traffic Studies (JSTS) Vol.2 No.4.

[4] Agus Setyo Muntohar.(2005) Geotechnical Properties of Rice Husk Ash Enhanced Lime stabilized Expansive Clay', Volume 13, No. 3, Edisi Xxxiii.

[5] Agus Setyo Muntohar.(2011), 'Uses of lime -rice husk ash and plastic fibers As mixtures-material in high-plasticity Clayey sub grade', Jurnal Ilmiah Semesta Teknika, Vol. 10, 146 No. 2, 2007: 145-154.

[6] Chakraborty & Saibal.(2010), 'Stabilization of Sub grades of Flexible Pavements with Admixtures', Indian Geotechnical Conference, GEO trendz December 16-18,2010IGS Mumbai Chapter & IIT Bombay.

[7] Dr. D. Koteswara Rao.(2012), 'A Laboratory Study on the Affect of Rice Husk Ash & Lime on the Properties of Marine Clay', International Journal of Engineering and Innovative Technology (IJEIT) Volume 2.

[8] IS: 2720 (Part 5). (1985), 'Determination of liquid limit and Plastic limit', Bureau of Indian Standards, New Delhi.

[9] Mohammed Y. Fattah (2013), 'Improvement of Clayey Soil Characteristics Using Rice Husk Ash', Journal of Civil Engineering and Urbanism Volume 3, Issue 1: 12-18

[10] Nadgouda, K.A.(2010). "The Effect of Lime Stabilization on Properties of Black Cotton Soil, Indian Geotechnical Conference Mumbai Chapter & IIT Bombay. 2010, GEO trendz December 16-18

[11] IGS Pankaj R. Modak (2012), 'Stabilisation of Black Cotton Soil Using Admixtures, International Journal of Engineering and Innovative Technology (EIT) Volume 1, Issue 5, May 2012.

[12] Sudhira Rath.(2011), 'Cost effectiveness of clayey soil & moorum, treated with fly ash- lime for construction of low volume roads', International journal of civil and structural engineering Volume 2.