Impact of rice husk ash and xanthan gum in road works by improving the characteristics of expansive soil (black cotton soil)– an inclusive study

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Abstract: The soils of Indian Black Cotton are well-known examples of Expansive soils, which display significant swelling and shrinkage in response to changes in moisture content. The distressing cyclical swelling and shrinking of soils under moisture fluctuations lead to serious failures. Stabilization of soil can be used to improve it in order to get around this. An agricultural industrial waste called rice husk ash is created when rice husk, a byproduct of paddy milling, is burned. In delta regions, it is widely distributed. It is a pozzolanic material that is widely distributed in India and has potential use in a number of geotechnical areas. In this stabilisation process, black cotton soil is mixed with RHA-lime and various percentages of cementitious material, particularly lime. Tests such as plasticity, compaction, swell, and CBR were also conducted with different water contents of OMCs (such as OMC + 2% water content and OMC + 5% water content). From the test findings, it can be concluded that adding lime reduces flexibility and increases strength. With the addition of RHA and lime, expansive soil gets higher CBR values at varied water contents more than 50% for dosages of 10% lime + 20% RHA and 10% lime + 30% RHA. The expansive soil becomes non-plastic, non-swelling, and has increased strengths, making it suitable for use as a building material for roads.

Keywords: Black cotton soil (problematic soil), RHA, Soil strength parameters.

1. INTRODUCTION

Expansive soils are to be had in most of the portions of Krishna, Guntur &North coastal Districts of Andhra Pradesh. Structures built on those soils had been going through differential settlements ensuing excessive damages. (Black cotton soils were spread across

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25% -overall land area of the world over, hassle of expansive soils has regarded as shearing and settlements of pavements, railway and, roadways, constructing foundations, dual carriageway embankments, irrigation systems, reservoir linings, sewer lines, canal and water lines. The impoverishment because of giant harm to highways walking over expansive soil sub-grades are expected to be in billions of greenbacks everywhere in the world.

1.1. Classification of Expansive Soils

According to their classification based on plasticity, expansive soils are often the clays designated as CL, CI, or CH. The silts labeled as ML, MI, MH classified based on plasticity also can be According to the index properties like PI, WS, linear shrinkage, clay content, swell potential, and other factors, several researchers have rated the magnificence of expansive soils. The houses obstacles of black cotton soil are offered in Table 1.

Table 1: Ranges of Problematic Soil

Characteristics	Range
LL (wL)	35 – 100 %
PI (Ip)	25 – 60 %
SL (ws)	10– 20 %
Volumetric shrinkage	45 – 55%
FSI	25 - 100%

1.2. Difficulties with expansive soils

- Vertical and diagonal cracks in interior and outdoor partitions.
- Wall cracks running laterally on both the inside and outside.
- Due to the cantilever movement, there are longitudinal cracks.

disconnection between the interior walls and the roof slab. Leaning against exterior walls.

1.3. Precautionary measure for expansive soils

If the soil has an excessive swelling potential, precautionary measures are required. These precautionary measures are widely divided into the subsequent categories:

- Replacing the expansive soil.
- Expansive soil modification.
- Design of the base to withstand and resist swelling.

1.4. Replacing the expansive soil

It is not pricey to put off that soil and update it with a great best granular soil. The granular soil must be compacted properly.

1.5. Modification of expansive soils

The traits of expansive soil may be changed to lessen its swell potential. Some of the usual place strategies are given below:

- Compaction
- Soil stabilization
- Water barriers installation
- Pre wetting
- Pressure injection

1.6. Stabilization

Soil stabilization is the system of mixing or combining suitable substances to soil to enhance its geotechnical properties and durability.

1.7. Uses of stabilization

• Resists shear in the layer.
• Evade immoderate elastic deflections that could result in fatigue cracking in the layer or in layers above.
• Keep off immoderate everlasting deformation through densification.

1.8. Types stabilization

- Mechanical stabilization
- Chemical stabilization
- Polymer stabilization

1.9. Stabilizing agents

These are hydraulic or non-hydraulic materials that react with moisture to form cementitious complex materials when they come into contact with water or when they are present around pozzolanic materials. The commonly utilized materials are:

- Lime
- Cement
- Fly ash
- Pozzolanas
- Blast furnace slag

1.10. Materials used

To take a look at the overall performance of RHA on Expansive soils, diverse chances of RHA become introduced to the dry mass of soil mass and examined for Geotechnical Characteristics consisting of Compaction, Differential FSI and unconfined Compressive energy and swell pressure. Black Cotton soil become amassed from APCRAD Undavalli Villages, Guntur and RHA become amassed from Tadepalli, Guntur district, Andhra Pradesh, India.

1.11. Expansive Soil

The Expansive Soil used on this research changed into accrued from Undavalli in Guntur District, Andhra Pradesh and their Geotechnical Characteristics are provided in Table 2 and particle length distribution curve, Relation among MDD and OMC, liquid limit, CBR value (soaked and soaked), UCS values are proven in Fig. 1 to Fig. 5.

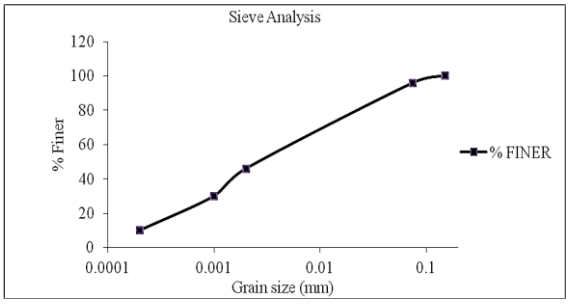

Fig.1: Unsterilized Black cotton soil grain size analysis curves of particle size (mm) Vs Percentage finer (%)

Table2: Characteristics of problematic soils

Description	Value
Gravel in percentage	0
Sand in percentage	5
Fines in percentage	95
a) Silt content in percentage	49
b) Clay content in percentage	46
W_L in percentage	72
W_P (percentage)	27
(Ip) percentage	45
Type	Brown Clay
I.S Classification	CH
(G_s)	2.68
OMC (in percentage)	25
MDD (kg/m^3)	1510
California bearing ratio (Un soaked condition) (%)	1.20
California bearing ratio (Soaked condition) (%)	1.0
UCS (t/m^2) in 0 days curing period	10.4
UCS (t/m^2) at 7 days curing	20
UCS (t/m^2) at 14 days curing	21
UCS (t/m^2) at 28 days curing	23
UCS (t/m^2) at 56 days curing	37
Undrained cohesion – C (t/m^2)	10
Angle of Internal Friction (Ø)-deg	15
FSI (%)	95
Swell pressure (Ps) (kN/m2)	92

The grain length distribution curves changed into received through IS sieve evaluation and the grain length distribution curves of the gentle clay had been received the usage of a hydrometer. The curve represents grading of numerous debris like gravel, sand, silt and clay (finer). Fig. 2 illustrates the relationship between maximum dry density, optimum moisture content, and dry density (g/cc) versus water content (%) for unsterilized gentle clay, while unsterilized gentle clay liquid limit where no. of blows vs. water content (%) is proven in Fig. 3.

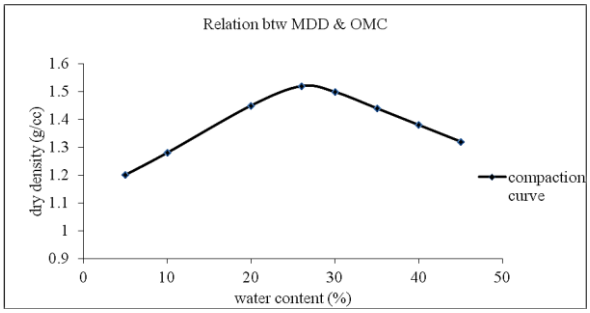

Fig.2: Relation between Unsterilized Black cotton soil MDD and OMC, dry density (g/cc) *vs* moisture content (%).

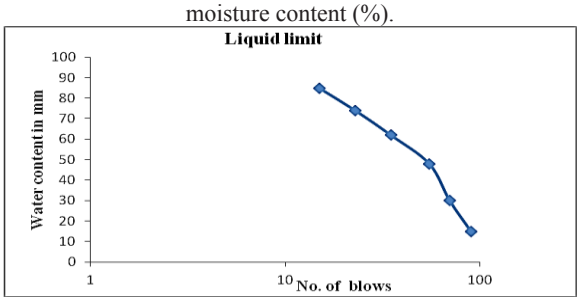

Fig.3: Unsterilized Black cotton soil liquid limit, no. of blows vs moisture content (%)

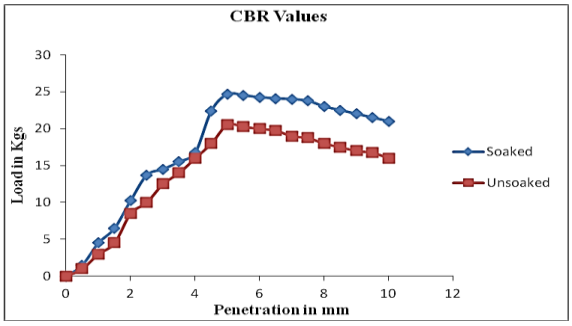

Fig.4: Unsterilized Black cotton soil California bearing ratio (CBR) load (kgs) *vs.* penetration (mm)

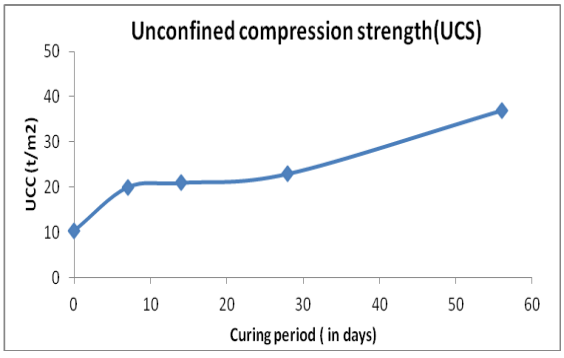

Fig.5: Unsterilized Black cotton soil UCS (unconfined compression strength), UCS(t/m2) Vs curing period (in days)

2. POZZOLANAS

Artificial pozzolanas which consist of ashes are merchandise acquired via way of means of manner of heat remedy of natural substances exhibiting pozzolanic behavior which incorporates clays, shales and high quality silicious rocks. Plants even as burnt silica taken from soils as vitamins stays withinside the lower back of the ashes contributing to pozzolanic detail. RHA(Rice husk ash) and rice straw and bagasse ash are rich in silica and make an brilliant pozzolana

3. RICE HUSK ASH

With the burning of rice husks, RHA is produced. When combustion is not complete huge amount of unburnt carbon is determined in the ash. The chemical composition of RHA produced via making use of the fluidized mattress kind furnace is said to be 80% SiO_2, 95% K_2O, 2% and unburnt carbon 3-18%. The pozzolanic interest of rice RHA is effective in enhancing the strength.

Fig.6: Rice Husk located at brick industry before Burning.

Rice husk is unusually high in ash, that's 92 to 95% silica, surprisingly porous and lightweight, with a completely excessive external floor location. Its absorbent and insulating residences are beneficial to many commercial packages, along with performing as a strengthening agent in building materials. Rice husks are processed into square shaped particle boards of before and after burning are represented in Fig.6 and 7 and their details of rice production in India provided Geotechnical (physical and chemical) homes of RHA tables three to five and Gradation curve compaction curve, SEM are shown Fig. 9 to 11.

Fig.7: Rice Husk Ash at brick industry after burning bricks

4. XANTHAN GUM

Xanthan gum is a chemical that can be made synthetically or through bacterial fermentation and is used as a thickening and gelling agent in food. Glucuronic acid, mannose, and glucose make up the polysaccharide that it is. It works well as a stabiliser, emulsifier, and thickening agent to keep ingredients from separating. It can be made via a fermentation technique from simple carbohydrates. The xanthan gum powder was allowed to dissolve in the water(OMC) at 6% to the weight of dry soil before testing of the RHA treated soil.

Fig.8: Xanthan gum in powder form before making a solution.

Table.3 Details of rice production in INDIA

S.No.	STATE	Quantity of Rice production (million tons)	Quantity of Rice Husk Ash (million tons)
1	Andhra Pradesh	14.24	0.62
2	Chhattisgarh	4.39	0.193
3	Karnataka	3.80	0.167
4	Orissa	6.81	0.299
5	Punjab	11.00	0.484
6	Uttar Pradesh	13.10	0.576
7	Tamil Nadu	5.18	0.227
8	West Bengal	15.01	0.6610
9	All India	99.15	4.35

Quantity of rice production is 99.15 million tons of Quantity of rice husk ash (RHA) is 4.35 million tons and RHA was collected from Chirravuru brick plant at Tadepalli, Guntur, Andhra Pradesh**.**

Table 4: Basic RHA Analysis

Property	Values
Fraction of Gravel (%)	0
Fraction of sand (%)	85
Fines percentage (%)	15
a) fraction of silt (%)	15
b) Fraction of clay (%)	0
W_L (%)	NP
W_P (%)	NP
I.S Classification	SM
G_s	1.81
OMC (%)	37
MDD (g/cc)	0.71
Angle of Shearing Resistance	36
CBR (%)	8.1
Cu	9.13
Cc	1.74
Volume of RHA for a mass of 1g	3.5cc

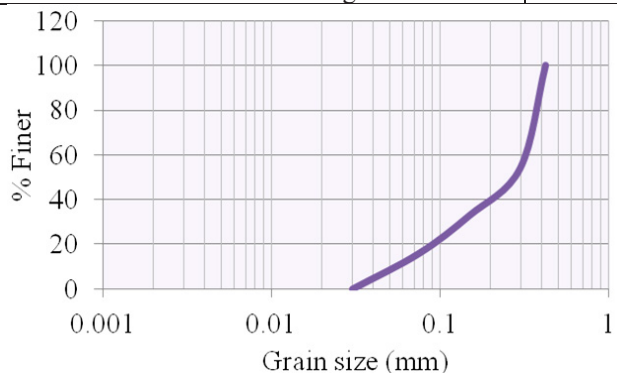

Fig.9: Gradation Curve for Rice Husk Ash

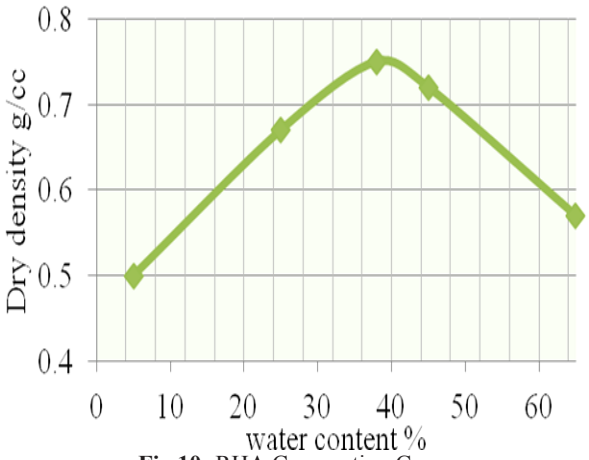

Fig.10: RHA Compaction Curve

Table 5: RHA Chemical Compounds

Chemical Composition	Percentage (%)
SiO2	97.69
Al2O3	0
Fe2O3	0.22
CaO	0.29
MgO	0
Na2O	0.41
K2O	1.39

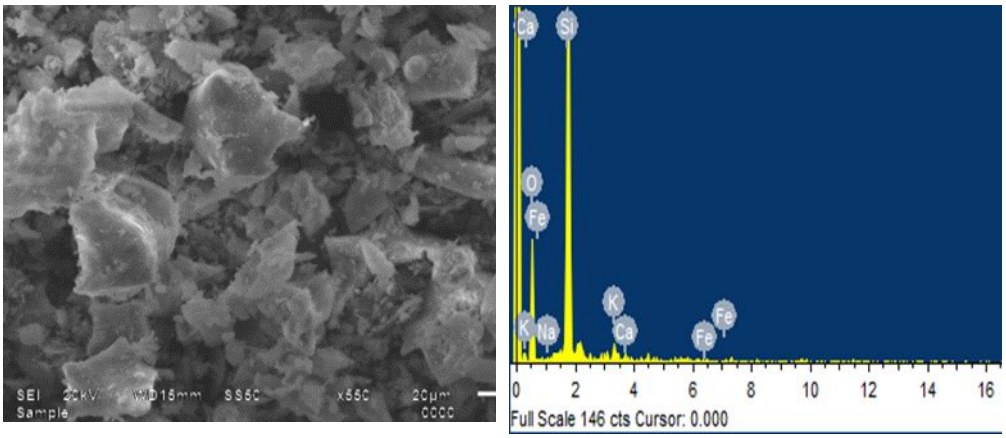

Fig. 11: SEM for RHA particle

• Majority of RHA debris are beneath first-rate sand variety and of angular form with hard ground texture, Zone IV.
• Sands with poor grading and non-plastic, incompressible fines are referred as as (SP) with Cu=9.13 and Cc= 1.74
• OMC of 37% and MDD of 0.71 g/cc.
• As can be seen from the compaction curve, rice husk ash and xanthan gum mixture achieves a reduced density in a broad version of the moisture content. The angle of shearing

resistance (Ø) is in the range of 36, which is lower than the unfatigued state, the CBR is 8.1%, and it has good drainage characteristics, and the permeability coefficient is 3.41 * 10-3cm/sec.

• Because of its low unique specific gravity, porous nature, and homogeneous distribution throughout the length of solids, RHA obtained low densities.

• When the chemical composition of RHA was evaluated using a scanning electron microscope (SEM), silica (SiO2) was found to make up 97% of the compound and oxides of calcium, iron, potassium, and sodium were found to be minor components.

5. LITERATURE REVIEW

Alrubayeet al. (2017) studied stabilization of gentle clay soil with numerous chances of lime and silica fume. The consequences proven that the extra power turned into accomplished for the specimen while handled with lime and silica fumes at five & six percent respectively. The soil accomplished most shear power while blended with the best percent of lime and silica fume five and six percentage. Lime and silica fumes expanded shear power and perspective of inner friction among soil with lime and soil with silica fume because of the pozzolanic response turned into greater powerful among the soil particle.

Alrubayeet al. (2018) studied stabilization of a gentle clay the use of lime and silica fume as a stabilizing agents by various the odds of lime (3%, five%, 7% and 9%) the use of silica fume as a pozzolanic fabric and located the extrude in soil index residences and engineering residences. The primary goal of this observe is to determine the bodily and consolidation residences of the handled soil at optimization of 6% silica fume with one-of-a-kind chances (3%, five%, 7% and 9%) of lime. Based on the findings, it has been determined that plasticity characteristics and compaction reside at 0% to 9% of lime. It is known that when silica fume and lime are mixed with the soil, the best amounts of lime—5% and 6%—give handled soil the most shear force.

According to Mohamed and Yahya (2020) growing the bearing masses of gentle clay through including the one-of-a-kind components like fly ash and lime and specifically located there's considerable growth in shear power and reduce withinside the compressibility. The goal of the observe is to behavior numerous laboratory assessments and examine check consequences at blending of soil with fly ash and lime at one-of-a-kind chances to locate index residences and compaction traits for each disturbed and undisturbed soil samples. The assessments finished are compaction and direct shear power. From the consequences, the best power of gentle clay turned into at 69 kPa through blending soil with 12% fly ash + 4% lime.

Lei et al. (2020) studied that Marine clay frequently want upgrades earlier than improvement and the way to stability out such sensitive soil is an extraordinary task. To deal with this issue clay stabilization with anionic polyacrylamide (APAM), mixed with lime is carried out. This investigation's main objective is to understand how APAM affects marine clay that has been treated with lime and the microstabilization mechanism. The unconfined compressive quality (UCS) checks and odometer checks had been carried out to discover the mechanical houses of stabilized clay. The check outcomes proven that with APAM measurements expanding, the adjustment effect in the beginning upgraded and, on this manner, debilitated.

Khazaei and Moayedi (2019) has indicated Black cotton soils are being expansive in nature which has terrible sign for lifestyles of the shape because it in the end reasons financially loss, out of the ordinary harm to systems and system. For all the delivered protected stabilizers. The samples dealt with 4, 6, 8, 10, and 12% obsession had been prepared. The compaction outcomes, extending estimation, Atterberg limits, and unconfined compressive strength (UCS) checks confirmed a discount in growing potential. This miracle changed

into brought to the checked addition in UCS and shear nature of stepped forward fashions with the aid of using waste and lime.

Gharib et al. (2019) said our creation shape confronted such a lot of troubles to assemble even as the use of gentle clay soils. By considering the curing lengths of 7, 28, 42, and 90 days, the influence of chitin nanofiber and rice husk ash on the permeability properties and bearing resistance of soft soils was investigated in this project. To locate the physical properties of dealt with soil FTIR, XRD and SEM are evaluated. Various charges of introduced stabilizing agent (1, 2, 4, 6 and 8%) with sorts in chitin nanofiber and rice husk particles percentage had been introduced to soil containing 6% lime at 2% of components and 6% of lime.

Kamaruddinet al. (2020) investigated near-specialized forms of soil stabilizers—lime and alkaline activator (AA) containing treated coir fibers as soil enhancers in marine clays—that have been tested. This cloth is not only environmentally friendly, but also inexpensive. Adding fibers to the treated marine clay has an effect for miles on increasing the soil's electricity. There, under each condition, the behaviour of the treated soil was examined using the oblique test, the bending test, and the unconfined compressive power test (UCC) at three distinct curing times (7, 28, and 90 days). The effect is the addition of fibers to each lime, and the alkaline activation shows the growth of the soil with additional ductility through field emission scanning electron microscopy (FESEM) and energy dispersive X-ray (EDX) brittle and microstructural analysis

Krishna et al. (2019) The APCRDA location of the highest floor location we propose is occupied using black cotton soil. State-of-the-art experiments use bagasse ash (BA) and brick dust (BD). Experiments will be conducted with the presence or absence of people such as introduced substances, evaluations, fees of 15%, 20%, 25%, 30%, and 35% brick dust. Bagasse ash is continuously in the 10% position. From there, examine the black cotton soil, bagasse ash, brick powder, body house, swelling pressure, and compression tests.

Krishnet Al. (2017) Waste disposal besides plastic baggage waste has become a first-class problem and waste plastic is incinerated for blatant disposal resulting in weed infestation. The combination is applied to the development of streets. In my study boards, I finished creating a comprehensive file on the tool for the use of plastic waste in bituminous mixtures and presented the exceptional examinations that were made on aggregates and bitumen.

Anand et al. (2020) The world is becoming a concrete jungle as a result of the world's population growth and daily increases in construction activity. The demand for land is rising for development purposes. One of India's primary soils is black cotton soil. The properties of black soil are very high. The experimental study was carried out on a piece of black cotton soil, whose properties were improved by adding admixtures such as quarry dust and lime. Various properties such as liquid limit, plastic limit, maximum dry density, optimum water content and California bearing ratio. Experimental research demonstrates that black cotton soil performs significantly better. Research into various literature studies revealed that adding more than 10% quarry dust to black cotton soil improved performance in some ways. As for lime, it's between 2% and 6%.

Reddy et al. (2017) now days the development on expansive soil is a tough venture for the engine as shape resisting in expansive soil cracks with none problems. There are various approaches to finish stabilization. Here, waste from sugar cane fabric is utilised as the stabiliser because it is an inexpensive alternative. A fibrous byproduct of the sugar cane production is bagasse ash. It already causes environmental pollution, thus using waste is necessary. The effectiveness of the bagasse ash was assessed using physical and electrical performance tests, specifically compaction and unconfined compressive strenghth, for the various dosages of bagasse used in the soil sample that was taken. These checks have been carried out to assess the development in electricity traits of the sub grade soil.

Keerthi et al. (2013) The demand for cement effect in a series of extreme kiln stains from cement factories is increasing day by day. Disposal of this first-class dirt poses an environmental threat. Research has been done on the exceptional arena components, soil stabilisation, cement production, pavement, and waste stabilisation to address this issue. The stabilisation of clayey soil using cement kiln waste is the focus of this work. Represents the transformation. Soil from Ravendrapadu, Andhra Pradesh, contains many exceptional homes and is blended with CKD in exceptional proportions to determine parameters such as dry density and moisture content material. By inspecting the value received, you will receive the full value in a typical percentage with a 50% proportional blend of CKD.

Megnathet et al. (2012) Several methods can be used to stabilise soil. The stabiliser employed in this case is a waste of plastic materials, which can be acquired readily and at a low cost, therefore stabilising utilising plastic waste is a financial approach. In order to increase the engineering performance of earth-painting soil, this article uses plastic, including the purchase of luggage, as an arming tool for CBR combining with soil. The dirt was accidently mixed with plastic strips made from scrap plastic. According to CBR experiments, adding sufficient amounts of plastic garbage to the soil greatly increases the electrical and deformational conductivity of the soil. The proposed method may be used in the construction of the waterfront/street, in the yard, etc.

Krishna et al. (2018) A variety of methods can be used to stabilise soil. The purpose of soil stabilisation is specifically to increase the strength characteristics of the soil and the subgrade soil's bearing capacity. Geogrids are the commonest stabilizer in stabilizing soils on curved pavements. Geogrids are specially used for soil reinforcement for special projects in production. In this painting, the main conversation is getting ready to stabilize the black cottony soil on the curved pavement through the use of a geogrid. The rising cost of black cotton soil CBR determines the electricity boom of black cotton soil on curved roads.

Sravan et al. (2019) Completed some experiments with black cotton soil to strengthen the soil. Black cotton soil can be very large, so it is not always used for construction work under the basement. Therefore, our tests show how to use black cotton soil for construction purposes. This concludes our research on the inclusion of lime and pond ash to enable black cotton soil. Changes in many soil homes, including liquid limits, plastic limits, and max. This completes several ratios that combine 10%, 15% and 20% of pond and lime. Therefore, we use waste cloth from thermal plants.

Srinadh et al.(2019) Soil Stabilization is one of the common technique now a days for amendment of soil in our each day lifestyles in production. As land cost is touching sky and due to boom in populace we want to construct withinside the to be had region. So we use this method referred to as Soil stabilization So via way of means of including those admixture the use of the economic waste that is to be had in a low value in order that we will without difficulty enhance the electricity of the soil due to the provision of admixtures in economy. After including the admixtures Soil need to be examined via way of means of a few primary checks of Unconfined Compressive Strength and additionally California bearing take a look at and additionally a few primary checks like Maximum Dry Density& Optimum Moisture Content, Plasticity index and liquid restrict etc.., need to be finished so as to check the stepped forward electricity of the soil.

Teja et al.(2017)infection of soil which occurred because of heavy poisonous steel and mixture of oil, petroleum, Greece is normally discovered at car restore workshops, in order that the soil is susceptible in electricity. Now a days there are numerous components are to bolster the soil in such locations like lime, cement, fly ash, GGBS etc. Because of getting extra binding ability cement is taken into consideration as a stabilizer furthermore the region which is chosen in CRDA place in A.P. In destiny this place may also have extra populace than beyond and the soil that is gift over there may also infected because of

excessive pollutants, growing in industries. The essential intention is to bolster the tainted soil anyplace gift and those effects will assist as destiny reference. The laboratory checks carried out are Grain Size Distribution, Swelling potential, Specific gravity, Standard Proctor Test, Atterberg limits, and Unconfined Compressive Strength (UCS).

Nandan et al. (2020) The point of interest in his research is to investigate the feasibility of soil stabilization through the use of rice husk ash and coconut coir fiber, resulting in waste recycling and soil stabilization. Providing an inexpensive and environmentally friendly approach. Many stabilization strategies can be adopted for soils that are not sufficiently stable. Different proportions of rice husk ash and coconut coir fiber (5% to 25%). The practice ended with five exceptional chances. 5%, 10%, 15%, 20% and 25% are combined with the sample. The premier cost of the effect is determined by a percentage of 15%, and the cost of unconstrained compressed power is 142kN / m2. Expansive clay is a very delicate soil and is no longer suitable for production without large-scale measures.

6. EXPERIMENTAL CONDITIONS

The following checks had been carried out at the soil and soil with RHA. The index and engineering homes of soil had been decided

. • **Grain length evaluation (IS:2720-component 4,1985)** The grain length distribution of any soil may be decided the use of the grain length evaluation, additionally referred to as mechanical evaluation. The primary technique of mechanical evaluation is to sieve the soil thru a fixed of sieves of well-known beginning length

• **Atterberg limits (IS:2720-component 5,1985)** • When determining the moisture content at which fine-grained clay and silt soils transition between the different phases, the Atterberg limits test is utilised. According to ASTM D 4318-00, the Atterberg limits are checked at the proportion of soil that is intended to be passed through a No. 40, 425-m, or 0.425-mm sieve.

• **Specific gravity (IS:2720-component 3,1980)** • This check is achieved to decide the particular gravity of soil with the aid of using the use of a pycnometer(coarse grained soils) and density bottle check(pleasant grain soils). A substance's specific gravity is determined by comparing its mass to that of an equivalent volume of gas-free distilled water at a given temperature.

• **Proctor's compaction check (IS:2720-component 8, 1983)** • The Proctor compaction check is a laboratory technique of experimentally figuring out the most desirable moisture content material at which a given soil kind becomes maximum dense and acquire its most dry density. The check is called in honor of Ralph Roscoe Proctor [de] , who in 1933 confirmed that the dry density of a soil for a given compaction attempt relies upon on the quantity of water the soil consists of throughout soil compaction .

• **Unconfined compression Test (UCS) (IS: 2720-Part 16, 1987)** • The UCS test is a laboratory test used to derive the uncertain compressive strength (UCS) of a rock sample. Uncertain compressive strength (UCS) represents the most axial compressive stress that a sample can withstand without zero confining stress

• **Consolidation Test (IS:2720-component 15,1965)** • Consolidation check is used to decide the charge and significance of soil consolidation while the soil is limited laterally and loaded axially. The Consolidation check is likewise called Standard Oedometer check or One-dimensional compression check. This check is performed on saturated soil specimens, specifically in cohesive soils.

• **California Bearing Ratio test (IS: 2720-Component 16, 1987)** • CBR test is a penetration check used to penetrate well soil with a well-known piston with a diameter of 50 mm (1.969 inches). Known charge of 1.25 mm / min. The pressure increases with the

strength of the infiltration, but at maximum, the pressure no longer grows fast and the proportion decreases, as in the case of normal overwhelmed rocks.

7. RESULTS AND DISCUSSION

To take a look at the impact of lime on expansive soil, various the share of Rice husk ash i.e. 0,10,20,30,40% via way of means of dry weight of soil had been introduced and correctly mixed, their offered plasticity characteristics, UCS values at special curing days ,CBR values soil blending RHA at special chances in desk 6 and proven graphs WL,PL,PI ,OMC,MDD ,UCS and CBR values in Fig. eleven to 15.

Table 6: Properties of soil with RHA mixes.

RHA (%)	XG %	LL (%)	PL (%)	IP (%)	OMC (%)	MDD (g/cc)	UCS(MPa) in days				CBR (%)	
							7	14	28	56	Unsoaked	Soaked
0	0	72	27	45	25	1.51	0.2	0.21	0.23	0.37	1.2	1
10	0.6	61	29	32	27	1.50	0.23	0.24	0.3	0.45	3	3.2
20	0.6	52	32	20	28.3	1.48	0.24	0.26	0.35	0.5	4	5.1
30	0.6	45	35	10	29.5	1.45	0.29	0.34	0.38	0.55	8	10.5
40	0.6	40	34	5	30.5	1.43	0.33	0.36	0.4	0.56	9	11

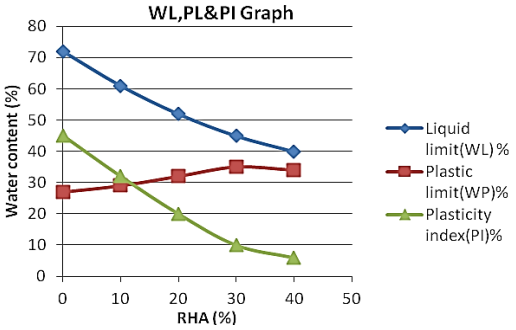

Fig.12: RHA % *vs* water contents

As the concentration of Rice husk ash is growing LL and PI values are lowering and growing W_P values. This phenomenon is sustained as much as 30% & 40% of RHA after it nearly misplaced its plasticity completely. The increase in plastic restriction is caused by the improvement of shear resistance among debris and the requirement of more water to mobilise for rolling. The decrease in liquid restriction is caused by the reduction in subtle double layer through absorption of calcium ions to floor location of clay debris.

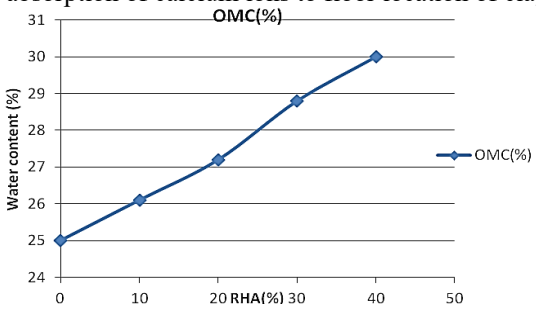

Fig.13: RHA % *vs* OMC

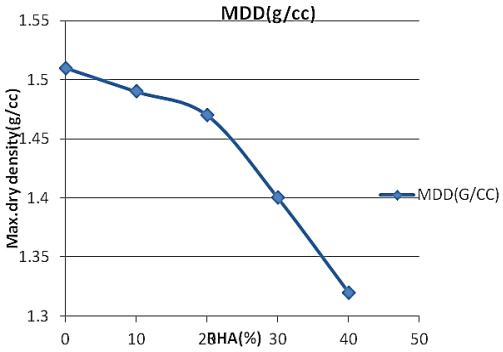

Fig.14: RHA % *vs.* MDD

This growth in top-of-the-line moisture content material values are because of the improvement of flocculated shape which resists the compaction effort. Decrease in MDD because of much less soil solids occupied withinside the given volume because of structural association of clay particles

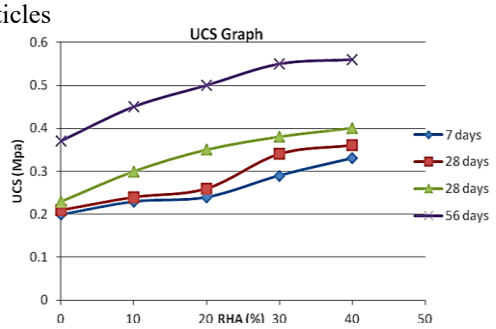

Fig. 15: RHA *vs.*UCS

This binding produces a more potent soil mix, ensuing in boom withinside the compressive power. Increasing percent of RHA will increase UCS values of 7 and 14, 28 and 56 days with curing time as proven in figure 15. The will increase in compression power values are because of improvement of cementitious compounds.

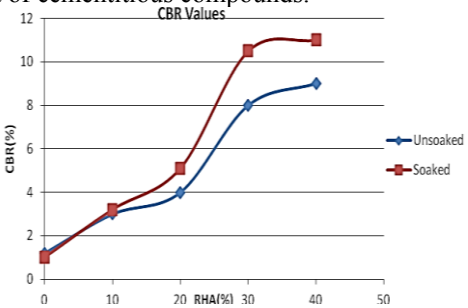

Fig. 16 RHA *vs.* CBR

As the percentage of RHA is increases CBR values (Soaked and Unsoaked) also increase. Due to the production of cementitious compounds between clay and lime particle, the CBR values (Soaked and Unsoaked) increase. which increases shearing resistance between particle to particle, their presented swelling characteristics and CBR values with OMC, without OMC (OMC+2% of moisture content and OMC+5% of moisture content) of soil with RHA in table 7 to table 9 and free swell index, swell pressure, permeability, CBR values at different water contents shown in Fig. 16 to 21.

Table 7: Properties (FSI, swell pressure and k) of RHA with soil

RHA (%)	FSI (%)	Swell pressure kN/m2	Hydraulic conductivity (K) cm/sec
0	95	92	3.41 ×10-3
10	90	87	4.35×10-3
20	75	62	6.10 ×10-3
30	40	42	9.34×10-3
40	10	25	1.7×10-3

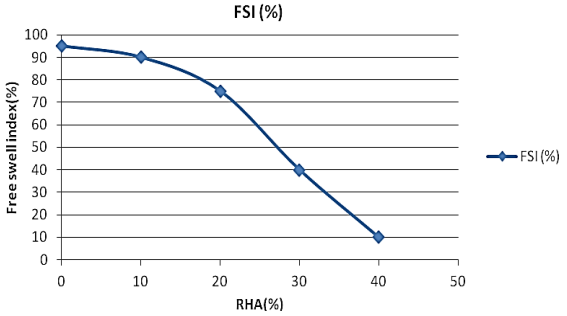

Fig. 17: RHA (%) *vs* Free Swell Index (%)

• Increasing percent of RHA unfastened swell values are lowering. At a dosage of 40 % it has become Moderate swelling.

• The lower in swelling traits is because of the lowering repulsive forces among clay particles.

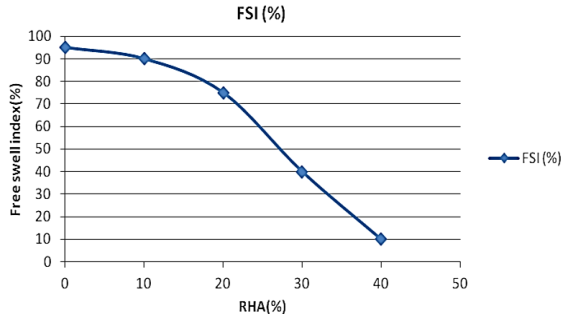

Fig.18: RHA (%)*vs.*swell pressure

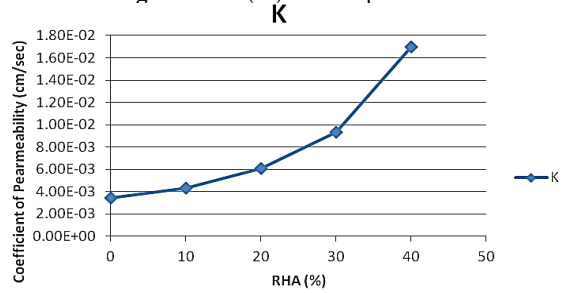

Fig.19: RHA (%) *vs.* coefficient of permeability

Table 8: CBR values of Soil+ RHA mixes with OMC+2% water

RHA	CBR (%)	
	Unsoaked	Soaked
0	1.2	1.0
10	2.5	3.0
20	3.5	4.5
30	7.0	10
40	8.5	10.5

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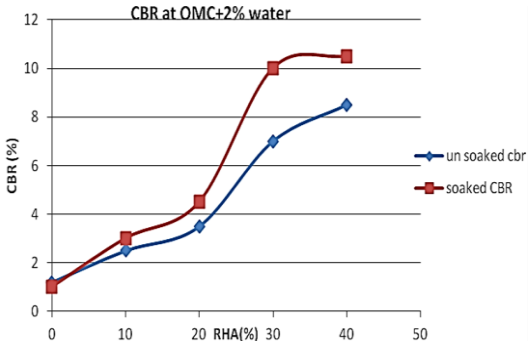

Fig. 20: RHA *vs.* CBR (OMC+2% water) Values

Table 9: CBR values of Soil RHA mixes with OMC+5 % water

Lime	CBR (%)	
	Unsoaked	Soaked
0	1.2	1.0
10	2.0	2.5
20	3.0	4.0
30	6.0	9.0
40	7.2	9.5

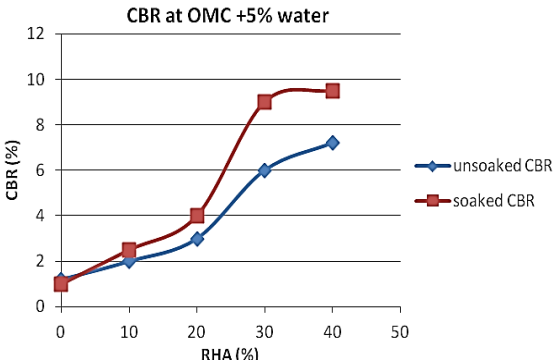

Fig.21: RHA *vs.* CBR (OMC+5% water)

The percentage of RHA is increasing and the value of swelling pressure is decreasing. At 30% of RHA, the swelling pressure is 42 kPa and the soil and RHA mixture shows very

low swelling levels. 40% of RHA shows moderate swelling. This is due to a decrease in repulsive force and an increase in shear resistance between particles, which reduces this thrust transfer to the surroundings of the environment in the form of a decrease in expansion pressure value. An increase in the percentage RHA caused an increase in the transmission coefficient value. The increase in the transmittance value is due to the development of the aggregated structure of the particles.

8. CONCLUSION

Based on laboratory test carried out in the soil rice husk ash mixture with XG, following conclusions can be developed.

1. Based on compaction characteristics it is evidenced that, with increase in percentage of additive (Rice Husk Ash+0.6% xanthan gum), OMC increases and MDD decreases.
2. Based on UCS test, the optimum percentage of the RHA obtained was 30%. The UCS values of the soil got increased based on the curing periods 7,14,28 and 56 days from 20 KN/m^2 to 56.02 KN/m^2 for 10,20,30% &40 RHA with 0.6%of xanthan gum. The improvement in strength was more than 100%.
3. Based on the California Bearing Ratio test, the optimum percentage additive obtained was 30%. The CBR value of the soil was increased from 1.2% to 11 % for 30% RHA. Then observed CBR values at OMC +2% water content and OMC with 5% water content. The improvement in CBR value was more than 100%.
4. From study it is observed that, RHA with XG can be effectively used as a soil stabilization material.

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