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Soil Stabilization with Rice Husk Ash

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ABSTRACT: Civil engineering projects located in areas with soft or weak soils have traditionally incorporated improvement of soil properties by using various methods. Soil Stabilization is being used for a variety of engineering works, the most common application being in the construction of road and pavements, where the main objective is to increase the strength or stability of soil and to reduce the construction cost by making best use of the locally available materials. Over the times, rice husk ash is the materials used for stabilizing soils. Thus the use of Agricultural waste (such as rice husk ash -RHA) will considerably reduce the cost of Construction and as well reducing the environmental hazards they cause. Rice husk is an agricultural waste obtained from milling of rice. About 108 tons of rice husk is Generated annually in the world. Hence, use of RHA for upgrading of soil should be encouraged. The present investigation has therefore been carried out with agricultural waste materials like Rice Husk Ash (RHA) which was mixed with soil to study improvement of weak sub grade in terms of compaction and strength characteristics. Silica produced from rice husk ashes have investigated successfully as a pozzolanic material in soil stabilization. Due to various construction development projects undertaken all over the world there is a substantial increase in the production of waste materials rice husk. Which create disposal problems. Rice husk waste is produced in large quantity in rice husk mills and is disposed in open land. Therefore use of rice husk in foundation of buildings and in road constructions to improve bearing capacity of soil and to reduce the area of open land needed for its disposal and to preserve environment through resource conservation. Results show strength improvements for all RHA and lime contents and time periods studied, and all materials produced can be defined as modified rather than stabilized. Improvement of sandy soils with RHA is an alternative to the final disposition with environmental, social and economic benefits. The focus of this research paper is to study the feasibility of stabilizing soil by using rice husk ash, thus re-using waste materials and providing an economical and ecofriendly method of soil stabilization.

KEYWORDS: Rice Husk Ash, Soil Stabilization, Silica, Pozzolanic Material, Waste Material, Sandy Soils

I. INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Soil is a significant component in the construction scenario. The longevity of a structure is directly dependent on the soil upon which it rests, therefore, it is necessary to ensure that the soil over which any structure is constructed, is firm or stable enough. Soil stabilization is a set of methods devised to improve the stability of soil. Various stabilization techniques prevail in the construction field utilizing diverse materials of varying properties.

Soil stability is an important criteria in the field of construction. For soil which lacks sufficient stability, various stabilization techniques can be adopted. Stabilization can increase the shear strength of soil and control the shrink-swell properties of soil, thus improving the load bearing capacity of the sub-grade to support pavements and foundations. A vast diversity of stabilization techniques exist. The focus of this research paper is to study the feasibility of stabilizing soil by using rice husk ash, thus re-using waste materials and providing an economical and ecofriendly method of soil stabilization. Rice husk ash (RHA) is a by-product of rice milling. Its use as a soil stabilizer is an alternative to the final disposition with environmental benefit. Because RHA is not self-cementitious, a hydraulic binder such a lime must be added to form cements to improve the soil strength.

In India the soil mostly present is Clay, in which the construction of sub grade is problematic. In recent times the demands for sub grade materials has increased due to increased constructional activities in the road sector and due to paucity of available nearby lands to allow excavate fill materials for making sub grade. In this situation, a means to overcome this problem is to utilize the different alternative generated waste materials, which cause not only environmental hazards and also the depositional problems. Keeping this in view stabilization of weak soil in situ may be done with suitable admixtures to save the construction cost considerably.

Because expansive clays are characterized by excessive compression, dispersion, collapse, low shear strength, low bearing capacity, and high swell potential, such soils are unsuitable for road sub grade layer construction. Expansive clays usually experience large volume changes depending on the amount of water contained in the soil voids. Such soils can form deep cracks in drier seasons and expand dramatically when wet. Such instability affects the strength performance of soil as a construction material.

Volume changes involving shrinkage and swelling cause deformation of the road surface, whereas increased moisture content in expansive clay soils significantly reduces soil bearing strength. Soils with low-bearing capacity can be strengthened economically for building purposes through the process of "soil stabilization" using different types of stabilizers.

1.2 SOIL STABILIZATION

Soil stabilization is the process of improving its geotechnical properties of soil. Soil stabilization involves the use of stabilizing agents (binder materials) in weak soils to improve its geotechnical properties such as compressibility, strength, permeability and durability. The components of stabilization technology include soils and or soil minerals and stabilizing agent or binders, soil stabilization aims at improving soil strength and increasing resistance to softening by water through bonding the soil particles together.

Soil stabilization is a physical, chemical, biological or combined method of altering the properties of a particular soil type to meet an engineering purpose. The prime objective of soil stabilization is to improve on-site materials to create a solid and strong sub-base and base courses. Originally, soil stabilization was done by utilizing the binding properties of clay soils, cement-based products such as soil cement, or utilizing the soil compaction technique and lime. Some of the renewable technologies are: enzymes, surfactants, biopolymers, synthetic polymers, co-polymer based products, cross-linking styrene acrylic polymers, tree resins, ionic stabilizers, fibre reinforcement, calcium chloride, calcite, sodium chloride, magnesium chloride and more.

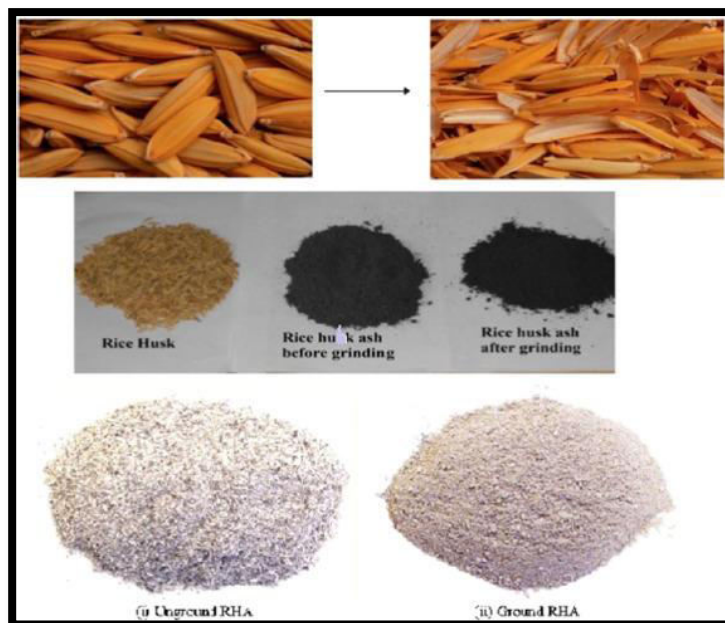
However, recent technology has increased the number of traditional additives used for soil stabilization purposes. Traditionally and widely accepted types of soil stabilization techniques use products such as bitumen emulsions. However, bitumen is not environmentally friendly and becomes brittle when it dries out. Portland cement has been used as an alternative to bitumen, in soil stabilization. This can often be expensive and not a "green" alternative. In recent times, green alternatives such as natural fibres have been used for soil stabilization and various other eco-friendly and economical methods are being devised.

Benefits of Soil Stabilization process can include:

- Higher resistance (R) values
- Reduction in plasticity
- Lower permeability
- Reduction of pavement thickness
- Aids compaction

1.3 RICE HUSK ASH

Rice Husk are the hard protective coverings of grains of rice. In addition, it can be put to use as building material, fertilizer, insulation material, or fuel. It contains large amount of iron oxide, opaline, lignin and silica. Rice Husk is separated from the rice grain by a process known as winnowing. It is used as fuels in kilns and furnaces in certain industries such as rice mills, bakeries, etc. and as a result of complete incineration, Rice Husk Ash can be obtained. Rice Husk Ash is chemically stable and its physical properties are similar to that of natural sand. The high angularity and friction angle of Rice Husk Ash contribute to excellent stability and load bearing capacity. This ash is a potential source of amorphous reactive silica. Silica is the basic component of sand, which is used with cement for plastering and concreting. Most of the ash is used in the production of Portland cement.



[Fig.1.1: Rice Husk]

1.4 OBJECTIVES OF THE STUDY

This study was oriented towards improving the strength of soil by using locally available agricultural and cattle waste to reduce the construction cost. The different stabilizing agents are used Rice husk ash (RHA). The present study was undertaken with the following objectives:

- To explore the possibility of using rural waste materials like RHA, in soil stabilization.
- To investigate the chemical and physical properties of stabilizing agents and their suitability.
- To investigate the physical and engineering properties of natural soil and stabilized soil by adding rice husk ash in soil.
- To compare the thickness of the pavement for maximum value of soaked CBR obtained for stabilized soil with soaked CBR value of natural soil.
- To check the ambit of reducing expansiveness and improving bearing capacity value by adding additives.

II. LITERATURE REVIEW

Research Summary 1

[Soil Stabilization using Rice Husk Ash and Cement (2014)]

Ms. Aparna Roy has presented a study which gives details about soil which is stabilized with different percentages of Rice Husk Ash and a small amount of cement. The results obtained show that the increase in RHA content increases the Optimum Moisture Content but decreases the Maximum Dry Density. Also, the CBR value and Unconfined Compressive Strength of soil are considerably improved with the Rice Husk Ash content.

Research Summary 2

[CBR variation in soil reinforced with natural fibres (2015)]

Mr. Dharmendra has put forth a comparative study on locally available soil, reinforced with Jute and Coir fibre. The Jute and Coir fibres were reinforced in different percentages in the soil samples. Both the soaked and unsoaked CBR values are measured and compared for both the fibres. Test results indicate that CBR value of soil increases with the increase in fibre content to some extent, and further addition of fibre results in decreased strength due to excess organic matter content.

Research Summary 3

[Effect of Rice Husk Ash on Soil Stabilization (2014)]

Qasim et al. have reviewed the stabilization of soil using sustainable methods. They concluded that Rice Husk Ash, with the presence of humidity, reacts with chemicals and improves strength and compressibility nature of soil.

Research Summary 4

[Review on Stabilization of Soil Using Coir Fibre (2015)]

Dr. Sharma et al. concluded that randomly distributed fibre reinforced soil have recently attracted increasing attention in geotechnical engineering. The main aim of this paper, therefore, is to review the, benefits, properties and applications of coir fibre in soil reinforcement through reference to published scientific data.

Research Summary 5

[Soil stabilization with rice husk ash and waste coir material (2017)]

Murali et al. Studied the usability and effectiveness of Rice Husk Ash and Waste Coir material reinforcement for deep foundation or raft foundation, as a cost effective approach and to evaluate the effects of Rice Husk Ash and Waste Coir material on the shear strength of unsaturated soil samples by carrying out Direct Shear Tests and Unconfined Compression Strength Tests.

III. PROPOSED METHODOLOGY**3.1 Methodology Adopted**

Specific gravity:- The specific gravity of soil particles (G) is defined as the ratio of the mass of a given volume of solids to the mass of an equal volume of water at 4° C.

The specific gravity G of the soil = $(W_2 - W_1) / [(W_4 - 1) - (W_3 - W_2)]$

Liquid limit:- It is the arbitrary limit of water content at which the soil just passes from the plastic state to the liquid state. Casagrande said to be the water at which 25 blows to the liquid limit cup will make two halves of a soil pat in the cup, separated by groove, join for a length of about 12mm

Plastic limit:- It is the arbitrary water content at which the soil tends to pass from the plastic state to the semi-solid state of consistency. Its done of the plastic limit is that is the minimum water content at which the soil can be rolled into a thread of 3mm diameter without crumbling. This is obtained by repeated trails

Plasticity index:- It is the numerical difference between liquid limit and plastic limit and it indicates the plastic range of the soil Plasticity index= Liquid limit – Plastic limit

IV. RESULTS AND DISCUSSIONS**4.1 Un-soaked California Bearing Ratio (CBR) test for soil – Rice Husk Ash Mixture****Table 4.1 Un-soaked CBR test for expansive soil only**

Sl. No.	Plunger penetration (mm)	Dial gauge readings	Applied load (kg)	CBR stress (kg/cm^2)	Standard load intensity (kg/cm^2)	CBR intensity (% age)
1	0	1	2.47	0.12		
2	0.5	6	14.82	0.75		
3	1	17	42.01	2.14		
4	1.5	24	59.30	3.02		
5	2	28	69.19	3.52		
6	2.5	32	79.07	4.03	70	5.75
7	3	36	88.95	4.53		
8	3.5	40	98.84	5.03		
9	4	44	108.72	5.54		
10	4.5	47	116.14	5.91		
11	5	50	123.55	6.29	105	5.99
12	5.5	52	128.49	6.54		
13	6	53	130.96	6.67		
14	6.5	54	133.43	6.79		

Table 4.2 Un-soaked CBR test for expansive soil + 10% rice husk ash mixture

Sl. No.	Plunger penetration (mm)	Dial gauge readings	Applied load (kg)	CBR stress (kg/cm ²)	Standard load intensity (kg/cm ²)	CBR intensity (% age)
1	0	4	9.88	0.49		
2	0.5	10	24.71	1.23		
3	1	28	69.19	3.45		
4	1.5	44	108.72	5.43		
5	2	52	128.49	6.42		
6	2.5	59	145.79	7.28	70	10.40
7	3	66	163.08	8.14		
8	3.5	72	177.91	8.88		
9	4	78	192.74	9.63		
10	4.5	83	205.09	10.24		
11	5	90	222.39	11.11	105	10.58
12	5.5	95	234.74	11.72		
13	6	98	242.16	12.09		
14	6.5	100	247.10	12.34		

Table 4.3 Un-soaked CBR test for expansive soil + 20% rice husk ash mixture

Sl. No.	Plunger penetration (mm)	Dial gauge readings	Applied load (kg)	CBR stress (kg/cm ²)	Standard load intensity (kg/cm ²)	CBR intensity (% age)
1	0	8	19.77	1.01		
2	0.5	25	61.77	3.15		
3	1	42	103.78	5.29		
4	1.5	60	148.26	7.55		
5	2	73	180.38	9.19		
6	2.5	83	205.09	10.45	70	14.93
7	3	96	237.21	12.08		
8	3.5	110	271.81	13.85		
9	4	122	301.46	15.36		
10	4.5	133	328.64	16.74		
11	5	139	343.47	17.50	105	16.67
12	5.5	146	360.76	18.38		
13	6	153	378.06	19.26		
14	6.5	157	387.94	19.76		

Table 4.4 Un-soaked CBR test for expansive soil + 30% rice husk ash mixture

Sl. No.	Plunger penetration (mm)	Dial gauge readings	Applied load (kg)	CBR stress (kg/cm ²)	Standard load intensity (kg/cm ²)	CBR intensity (% age)
1	0	3	7.41	0.37		
2	0.5	9	22.24	1.13		
3	1	19	46.95	2.39		
4	1.5	29	71.66	3.65		
5	2	37	91.42	4.66		
6	2.5	52	128.49	6.54	70	9.35
7	3	57	140.84	7.17		
8	3.5	65	160.61	8.18		
9	4	71	175.44	8.94		
10	4.5	77	190.26	9.69		
11	5	83	205.09	10.45	105	9.95
12	5.5	86	212.50	10.82		
13	6	89	219.92	11.20		
14	6.5	91	224.86	11.45		

Table 4.5 Un-soaked CBR test for expansive soil + 40% rice husk ash mixture

Sl. No.	Plunger penetration (mm)	Dial gauge readings	Applied load (kg)	CBR stress (kg/cm^2)	Standard load intensity (kg/cm^2)	CBR intensity (% age)
1	0	2	4.94	0.25		
2	0.5	7	17.30	0.88		
3	1	17	42.01	2.13		
4	1.5	28	69.19	3.51		
5	2	38	93.90	4.77		
6	2.5	46	113.67	5.77	70	8.25
7	3	52	128.49	6.53		
8	3.5	58	143.32	7.28		
9	4	63	155.67	7.91		
10	4.5	68	168.03	8.53		
11	5	72	177.91	9.04	105	8.61
12	5.5	76	187.80	9.54		
13	6	80	197.68	10.04		
14	6.5	83	205.09	10.42		

Table 4.6 Un-soaked CBR test for expansive soil + 50% rice husk ash mixture

Sl. No.	Plunger penetration (mm)	Dial gauge readings	Applied load (kg)	CBR stress (kg/cm^2)	Standard load intensity (kg/cm^2)	CBR intensity (% age)
1	0	2	4.94	0.25		
2	0.5	5	12.36	0.63		
3	1	14	34.59	1.76		
4	1.5	23	56.83	2.90		
5	2	33	81.54	4.16		
6	2.5	41	101.31	5.16	70	7.37
7	3	48	118.61	6.04		
8	3.5	55	135.91	6.93		
9	4	61	150.73	7.68		
10	4.5	66	163.09	8.31		
11	5	71	175.44	8.94	105	8.51
12	5.5	75	185.33	9.44		
13	6	79	195.21	9.95		
14	6.5	82	202.62	10.32		

V. CONCLUSION

In countries with high rice production, rice husk and RHA are residues whose final disposition is a big concern, the use of RHA for soil improvement is particularly attractive. It reduces the environmental impact, disposal costs and preserves non-renewable resources such as soils and rocks. It is an economic alternative, particularly in roads, by giving value to a waste material, enabling the use of low-quality materials with reducing transport costs, and improving the pavement performance with reducing maintenance and rehabilitation costs.

VI. FUTURE SCOPE

Rice husk ash along with another additive like lime, murrum, cement, and other such materials can be used together, and may be varied in quantity to obtain the best possible stabilizing mixture.

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