Soil Stabilization by Rice Husk Ash and Waste Coir Material

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Abstract: The main objective of this paper is to explore the use of Rise Husk Ash and Waste Coir material in Geotechnical Engineering applications 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. The results obtained are compared and inferences are drawn towards the usability and effectiveness of Rise Husk Ash and Waste Coir material reinforcement as a replacement for deep foundation or raft foundation, as a cost effective approach.

Keywords: Rise Husk Ash, Waste Coir material, Direct Shear Test and Unconfined Compressive Strength Test

I. INTRODUCTION

For any land-based structure, the foundation is very important and has to be strong to support the entire structure. In order for the foundation to be strong, the soil around it plays a very critical role. So, to work with soils, proper knowledge about their properties and factors which affect their behavior is essential. The process of soil stabilization helps to achieve the required properties in a soil needed for the construction work. From the beginning of construction work, the necessity of enhancing soil properties has come to the light. Ancient civilizations of the Chinese, Romans and Incas utilized various methods to improve soil strength etc., some of these methods were so effective that their buildings and roads still exist.

In India, the modern era of soil stabilization began in early 1970's, with a general shortage of petroleum and aggregates, it became necessary for the civil engineers to look at the means to improve soil rather than replacing the entire poor soil at the building site. Soil stabilization was used but due to the use of obsolete methods and also due to the absence of proper technique, soil stabilization lost favor. In recent times, with the increase in the demand for infrastructure, raw materials and fuel, soil stabilization has started to take a new shape. With the availability of better research, materials and equipment, it is emerging as a popular and cost-effective method for soil improvement.

Different methods can be used to improve and treat the geotechnical properties of the problematic soils (such as strength and the stiffness) by treating it *in situ*. These methods include densifying treatments (such as compaction or preloading), pore water pressure reduction techniques (such as dewatering or electro-osmosis), the bonding of soil particles (by ground freezing, grouting, and chemical stabilization), and use of reinforcing elements (such as geotextiles and stone columns)

Here, in this study, soil stabilization has been done with the help of rice husk ash and randomly distributed waste coir fibers .The improvement in the shear strength parameters has been stressed upon and comparative studies have been carried out using different methods of shear resistance measurement.

II. PREPARATION OF SOIL SAMPLES

Following steps are carried out while mixing the rice husk ash and coir to the soil

1. All the soil samples are compacted at their respective maximum dry density (MDD) and optimum moisture content (OMC), corresponding to the standard proctor compaction test
2. The rice husk ash is added at 1%, 2%, and 3%
3. The content of coir in the soil is herein decided by the following equation:

$$\rho_f = \frac{W_f}{W}$$

Where, ρ_f = Ratio of coir material

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Wf = Weight of the coir
W = Weight of the air-dried soil

- The different values adopted in the present study for the percentage of coir material are 0.05, 0.1, and 0.15.
- In the preparation of samples, if rice husk ash and coir are not used then, the air-dried soil was mixed with an amount of water that depends on the OMC of the soil.
- If rice husk ash was used, the adopted quantity of rice husk ash was first mixed into the air – dried soil by hand, so that a fairly homogeneous mixture is obtained, and then mixed with an amount of water that depends on the OMC of the soil.
- If coir reinforcement was used, the adopted content of coir was first mixed into the air-dried soil in small increments by hand, making sure that all the coir was mixed thoroughly, so that a fairly homogenous mixture is obtained, and then mixed with an amount of water that depends on the OMC of the soil.

III.PROPERTIES OF UNREINFORCED SOIL SAMPLE

S.NO	DESCRIPTION	VALUE
1	Specific Gravity	2.53
2	Free Swell Index	13%
3	Liquid Limit	38%
4	Plastic limit	22%
5	Plasticity Index	16%
6	Maximum Dry Density	1.85 gm/cm^3
7	Optimum Moisture Content	16.2%
8	Cohesion	0.225 Kg/cm^2
9	Angle of Internal friction	22.1^0
10	Unconfined compressive strength	0.122a

IV.EFFECT OF RICE HUSK ASH ON SHEAR STRENGTH PROPERTIES OF SOIL

Rice husk ash was first mixed into the air – dried soil by hand, so that a fairly homogeneous mixture is obtained, and then it is mixed with an amount of water that depends on the OMC of the soil. Later the soil sample is compacted up to the maximum dry density. The direct shear test and the unconfined compressive strength test were conducted on those soils samples.

Rice husk ash (%)	1	2	3
Cohesion (Kg/cm^2)	0.237	0.249	0.267
Angle of internal friction	23.2^0	24.8^0	27.1^0
Unconfined compressive Strength (Mpa)	0.145	0.170	0.183

V.EFFECT OF COIR MATERIAL ON SHEAR STRENGTH PROPERTIES OF SOIL

Coir material was first mixed into the air-dried soil in small increments by hand, making sure that the coir was mixed thoroughly, so that a fairly homogenous mixture is obtained, and then mixed with an amount of water that depends on the OMC of the soil. Later the soil sample is compacted up to the maximum dry density. The direct shear test and the unconfined compressive strength test were conducted on those soils samples.

Coir material (%)	0.05	0.10	0.15
Cohesion (Kg/cm^2)	0.258	0.276	0.294
Angle of internal friction	24.1^0	26.3^0	27.8^0
Unconfined compressive Strength (Mpa)	0.139	0.171	0.194

VI.INFERENCES FROM DIRECT SHEAR TEST

1). Due to 1% rice husk ash the cohesion value of soil increases from 0.225 Kg/Cm^2 to 0.237 Kg/Cm^2, a net of 5.33 %.
2). Due to 2% rice husk ash the cohesion value of soil increases from 0.225 Kg/Cm^2 to 0.249 Kg/Cm^2, a net of 10.67 %.
3). Due to 3% rice husk ash the cohesion value of soil increases from 0.225 Kg/Cm^2 to 0.267 Kg/Cm^2, a net of 18.67 %.
4). Due to 1% rice husk ash the angle of internal friction of soil increases from 22.1^0 to 23.2^0 , a net of 4.97 %.
5). Due to 2% rice husk ash the angle of internal friction of soil increases from 22.1^0 to 24.8^0 , a net of 12.27 %.
6). Due to 3% rice husk ash the angle of internal friction of soil increases from 22.1^0 to 27.1^0 , a net of 22.62 %.
7). Due to 0.05% coir fiber the cohesion value of soil increases from 0.225 Kg/Cm^2 to 0.258 Kg/Cm^2, a net of 14.67 %.
8). Due to 0.10% coir fiber the cohesion value of soil increases from 0.225 Kg/Cm^2 to 0.276 Kg/Cm^2, a net of 22.67 %.
9). Due to 0.15% coir fiber the cohesion value of soil increases from 0.225 Kg/Cm^2 to 0.294 Kg/Cm^2, a net of 30.67 %.
10). Due to 0.05% coir fiber the angle of internal friction of soil increases from 22.1^0 to 24.1^0 , a net of 9.05 %.
11). Due to 0.10% coir fiber the angle of internal friction of soil increases from 22.1^0 to 26.3^0 , a net of 19.00% .
12). Due to 0.15% coir fiber the angle of internal friction of soil increases from 22.1^0 to 27.8^0 , a net of 25.08 %.

VII.INFERENCES FROM UNCONFINED COMPRESSIVE STRENGTH TEST

1). Due to 1% rice husk ash the Unconfined compression strength value of soil increases from 0.122 Mpa to 0.145 Mpa,
a net of 18.85 %.
2). Due to 2% rice husk ash the Unconfined compression strength value of soil increases from 0.122 Mpa to 0.170 Mpa,
a net of 39.34 %.
3). Due to 3% rice husk ash the Unconfined compression strength value of soil increases from 0.122 Mpa to 0.183 Mpa,
a net of 50.00 %.
4). Due to 0.05% of coir fiber the Unconfined compression strength value of soil increases from 0.122 Mpa to 0.139 Mpa,
a net of 13.94 %.
4). Due to 0.10% of coir fiber the Unconfined compression strength value of soil increases from 0.122 Mpa to 0.171 Mpa,
a net of 40.16 %.
6). Due to 0.15% of coir fiber the Unconfined compression strength value of soil increases from 0.122 Mpa to 0.194 Mpa,
a net of 59.02 %.

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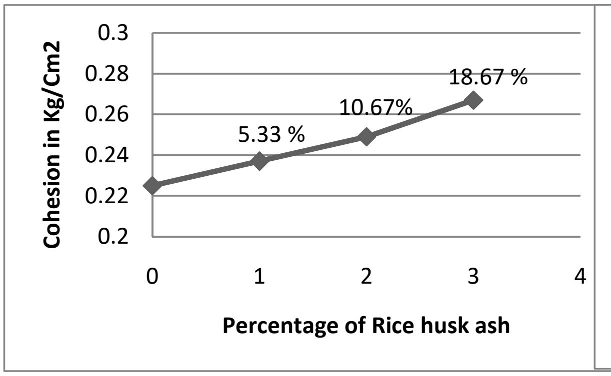
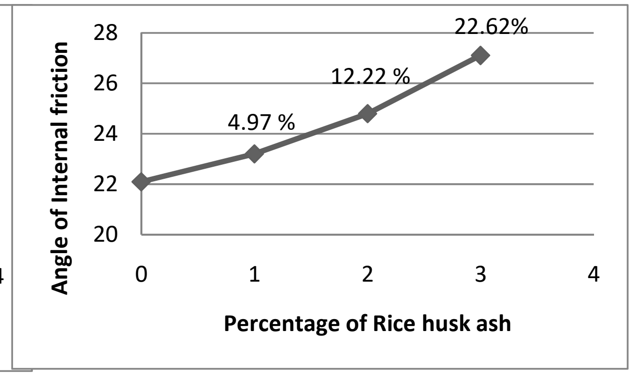


Fig : 1



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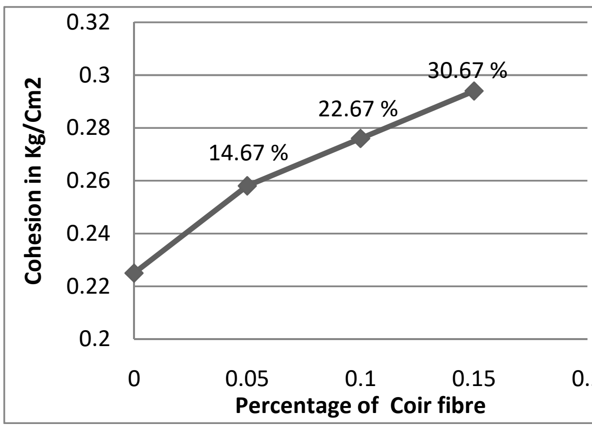

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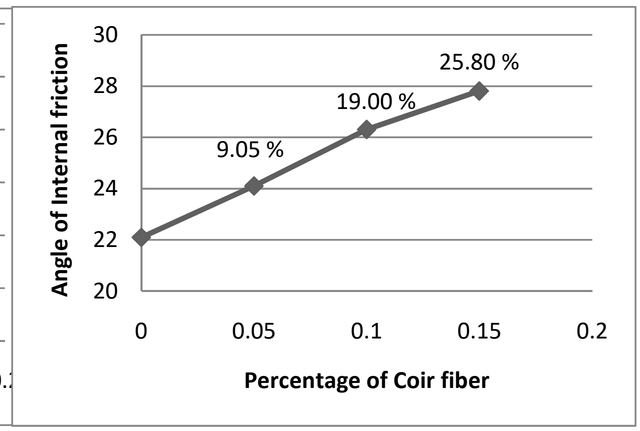

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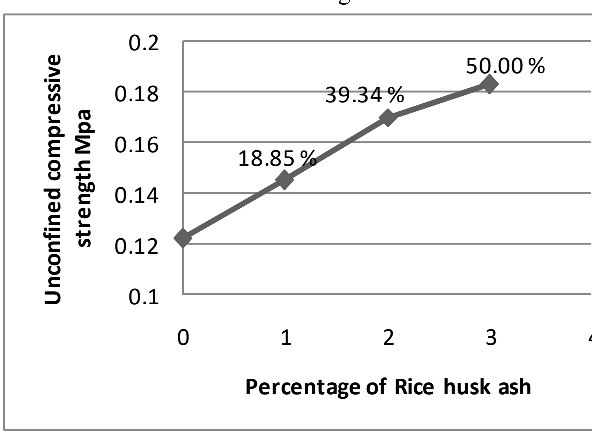

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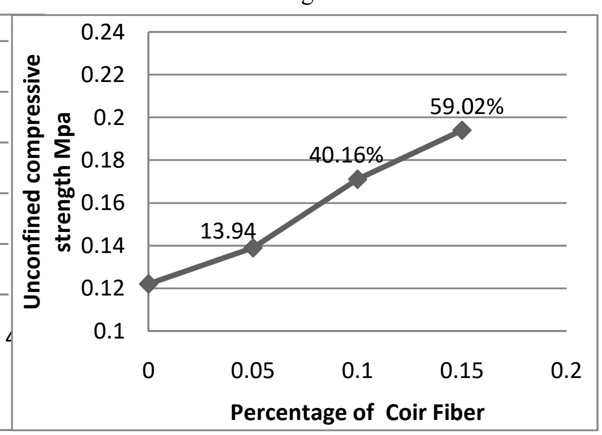

Fig : 6

VIII.RESULTS AND DISCUSSION

1. Based on direct shear test on soil sample, with rice husk ash percentages of 1%, 2% and 3%, the increase in cohesion was found to be 5.33%, 10.67% and 18.67% respectively (illustrated in fig : 1). The increase in the internal angle of friction (φ) was found to be 4.97%, 12.27% and 22.62% respectively (illustrated in fig : 2). Since the net increase in the values of c and φ were observed to be 18.67%, from 0.225 kg/cm2 to 0.267 kg/cm2 and 22.62%, from 22.1^0 to 27.1^0 degrees respectively, for this soil, the rice husk ash is recommended for this soil stabilization.
2. Based on direct shear test on soil sample with coir reinforcement of 0.05%, 0.1% and 0.15%, the increase in cohesion was found to be 14.67%, 26.67% and 30.67% respectively (illustrated in fig : 3). The increase in the internal angle of friction (φ) was found to be 9.05%, 19.00% and 25.08% respectively (illustrated in fig : 4).

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Since the net increase in the values of c and φ were observed to be 30.67%, from 0.225 kg/cm2 to 0.294 kg/cm2 and 25.08%, from 22.1^0 to 27.8^0 respectively, for this soil, randomly distributed coir reinforcement is recommended for this soil stabilization.

3. Based on unconfined compressive strength test on soil sample with rice husk ash of 1%, 2% and 3%, the increase in unconfined compression strength was found to be 18.85%, 39.34% and 50.00% respectively (illustrated in fig : 5).. This increment is substantial and applying it for soils similar to this soil sample is effective.
4. Based on unconfined compressive strength test on soil sample with coir of 0.05%, 0.1% and 0.15%, the increase in unconfined compression strength was found to be 13.94%, 40.16% and 59.02% respectively (illustrated in fig: 6).. This increment is substantial and applying it for soils similar to the this soil sample is effective.

IX.CONCLUSIONS

Overall it can be concluded that the rice husk ash and coir fiber can be considered to be good in ground improvement technique specially in engineering projects on weak soils where they can act as a substitute to deep/raft foundations, reducing the cost as well as energy.

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