An Experimental Study on Soil Modification using Rice Husk Ash

Regina Mary.I[1] *, Dr.T.Bhagavathi Pushpa*[2]*, Mahendran.M*[3]

[1]*Assistant Professor, Department of Civil Engineering, MZCET, Pudukkottai, Tamil Nadu, India*

[2]*Assistant Professor, Department of Civil Engineering,Anna University,UCE, Ramanathapuram, Tamil Nadu,India*

[3]*PG Student, MZCET, Pudukkottai, Tamil Nadu, India*

[1]reginadensingh2016@gmail.com

[2]pushpathillai@gmail.com

[3] mahebala007@gmail.com

Abstract— Sand possess no cohesion and there is a need to improve the properties if it is used in embankments, foundations etc. Many researches have been done using various admixtures and natural waste materials are mixed in soil to impart the soil modification . Rice Husk Ash (RHA) is one of the natural waste materials and many experimental work has been done in various aspects of construction industry. In this paper an attempt is made to study the behaviour of silty sand replaced with rice husk ash in the order of 0%, 5%,10%,15%and 20%.Lab test such as index properties of excavated soil, Standard Proctor Compaction Test, Direct Shear Test and California Bearing Ratio Test were conducted with the above percentage replacement of RHA in silty sand. Results show that all the index properties of silty sand increases and was modified with the increase in % of replacement.

Keywords— Rice Husk ash, Index properties, Soil modification, shear strength,silty sand

I. INTRODUCTION

Soil stabilization can be done by adding additives or waste materials.Chemical stabilization incorporates chemical reactions for improving the geotechnical properties of soil.Soil modification and soil stabilization is included in soil improvement technique.Soil modification means addition of lime,cement or such additives to change the index properties of soil.But soil modification is made to increase the shear strength,CBR value etc. Nowadays there is a need for natural and environmental friendly materials.Fibers such as coconut coir, sisal fibers, polypropylene fibers, aramid fibre, basalt fibre, nylon fibre, carbon fibre etc can be added to improve the strength and stiffness of soil. The addition of these fibers is financially high and the same also the additive such as cement and lime.Rice Husk Ash is a waste material and the disposal itself is a big problem. When burnt rice husk ash contains large amount of silicates which increases the strength and can be used in road construction.

II. LITERATURE STUDIES

Mousa et al., (2010) studied the effects of polypropylene fibers on sandy soil. He used two types of polypropylene fibers ,one highly flexible with flat profile and other with relatively high stiffness and crimpled profile. He found that the ductility of sand increases and the increase in aspect ratio of fibre increases the shear strength properties of sand.

Chore et al., (2011) carried out the work using polypropylene fiber and fly ash in sand. The studies concluded that 1% polypropyene fiber is the optimum quantity and the sand performance is good while using 50% sand and 50% fly ash in proportion.

Tiwari et al.,(2013) studied the CBR values of polypropylene and coir fibers under soaked and unsoaked condition. Results show that upto 0.5% to 1% addition of fibers increases the CBR value which may improve the strength due to heavy loads transferred to sub base soil. This fibers may be used in embankments and other earth works.

Patel et al., (2014) conducted an experimental study of black cotton soil mixed with rice husk ash, fly ash and lime. From direct shear test they found that the C value is increases , Φ value decreases in treated soil and CBR value of Black Cotton soil also increases rapidly by using rice husk ash, lime and flyash.

Ndepete and Sert (2016) investigated the behavior of soil mixed with basalt. It is concluded that undrained shear strength of silty soils increases with the inclusion of basalt fibers. The optimum fiber content corresponding to maximum improvement in strength is found to be 1.5%. The additional gain in strength is not observed when the fiber content is increased further to 2%.

Anurag et al., (2017) performed the work using Rice Husk Ash in silty sand. He concluded that 11% of RHA is the optimum replacement. Further addition of RHA decreases the value of CBR.

Zambri et al.,(2018) studied the soil stabilization using lime and cement in Peat soil. Peat reaches the high shear strength with the addition of lime when compared with cement. With the increase in addition of additives the strength also increases.

In this paper the silty sand was replaced with the Rice Husk Ash in the order of 0%,5%,10%,15% and 20% and the standard proctor compaction test, direct shear test and California bearing ratio (CBR) tests are performed in the laboratory to study the change of index properties of RHA inculcated in silty soil. Based on the tests ,the addition of RHA increases the maximum dry density,CBR value etc.

III. Properties of Materials

3.1 Silty Sand

The present case study deals with the use of rice husk ash in silty soil. The soil for the present study was collected from the campus of the college. It was red sand called theri sand and the index properties were tested in the laboratory and are listed in the following table

Fig 1 Silty Sand with Rice Husk Ash

Table 1.1 Properties of used soil

Property	Value
Optimum moisture content (%)	11.35
Maximum dry density (g/cc)	1.82
CBR value (2.5mm penetration) (%)	6.24
IS 1498 (1970) classification	Silty sand
Internal friction angle (ϕ)	29°

3.2 Rice Husk Ash (RHA)

Rice Husk Ash is obtained as a by product obtained from the grinding of puffed rice. It contains a large amount of silicate. In order to improve the soil properties Rice Husk ash is added to the excavated soil and the index properties of soil was studied.

Table 1.2 Properties of RHA

S.No.	Constituents	Composition(%)
1.	SiO_2	83.2
2.	Al_2O_3	2.8
3	Fe_2O_3	1.4
4	CaO	3.7
5	MgO	0.3
6	Loss on Ignition	8.6

3.3. Soil Modification

As per the review of literature it has been found that the soil can be stabilized by mechanical stabilization or chemical stabilization. Mechanical stabilization can be done by rollers,compaction,etc Chemical stabilization can be achieved by lime,cement,flyash,wood ash,rice husk ash etc. In this experimental program it was decided to replace the excavated soil by rice husk ash.RHA was replaced by 5%,10%,15% and 20%.The test was initiated by mixing the processed rice husk ash with the soil in a dry state. An optimum percentage water was added to perform the test. As the percentage of RHA increase it was difficult to maintain the workability as it was dry. Direct shear Test, Proctor Compaction test and CBR test was done to study the behavior of silty sand. Soil modification was done to change the geotechnical properties of soil.

IV. RESULTS AND DISCUSSION

4.1 Standard Proctor Compaction Test

Standard proctor compaction test was performed for soil with and without rice husk ash the soil can be densified by reduction in water content and expelling of air.This densified soil reduces settlement, landslides etc.The RHA was added from 5%,10%,15% and 20%.The test was conducted as per standards to find the optimum moisture content and dry density. From the results it was found that the dry density decreases with the percentage addition of rice husk ash.Fromthe test result it has inferredthat 20% replacement of RHA givesthe optimum water content and the maximum dry density occursat 5% replacement of RHA.

Table 1.3 Standard Proctor Compaction Test

% replacement of Rice Husk Ash	Optimum water content (%)	Dry density (g/cc)
0	11.35	1.82
5	12.4	2.24
10	15.8	2.18
15	16.6	1.86
20	20.45	1.75

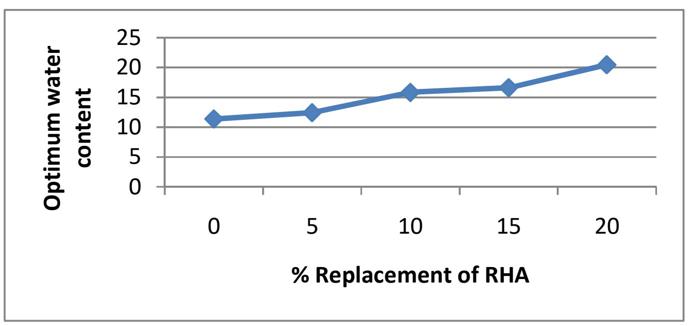

Fig 2 Optimum water content

4.2 Direct shear test

Direct shear test was conducted to study the shear strength parameters namely angle of internal friction and cohesion.This test is an important engineering property to study the interaction of soil completely. The direct shear test result was studied by taking the horizontal stress,vertical stress,horizontal and vertical displacement ,friction angle and cohesion.Rice Husk Ash is added in the given proportions.The shear strength parameter increases with the addition of RHA.RHA can be added to cohesionless soil as an effective soil modification material when compared to cohesive soil.Testresult show that maximum value occurs at 20% replacement of RHA and it increases rapidly.

Table 1.4 Direct Shear Test

% replacement of Rice Husk Ash	Angle of internal friction (ϕ) (degree)
0	29.00
5	30.12
10	31.52
15	32.48
20	33.72

4.3 California Bearing Ratio Test

The load penetration curve for RHA mixed with silty soil is shown below. The CBR value is calculated for 2.5 mm and 5 mm penetration. Normally CBR value for 2.5 mm penetration is higher.In this study the CBR value increases with the increase in load for 2.5 mm penetration. The mixing of RHA is not easy beyond 1.5 %.The CBR value is used in the design of flexible pavement. The CBR value obtained from this test satisfies as a sub base material as per IRC-37. Table 1.5 and fig 1.3 shows that the CBR value is high for 2.5 mm penetration.

Table 1.5 CBR Value (%)

% replacement of Rice Husk Ash	2.5mm penetration (%)	5mm penetration (%)
0	6.24	5.82
5	7.42	6.80
10	8.92	7.42
15	10.42	9.84
20	11.54	10.96

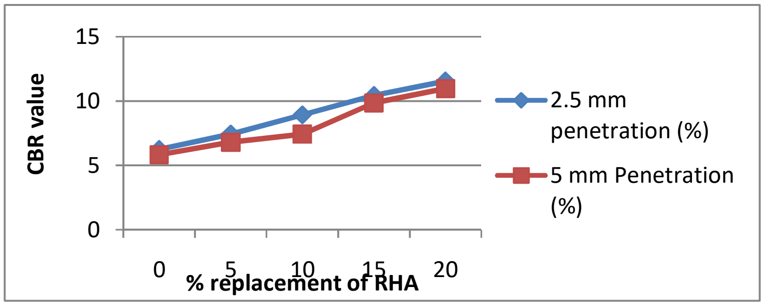

Fig 3 CBR Test

V. CONCLUSION

Based on the information derived from the above experimental work, the following conclusions have been made:

- The Maximum Dry density of the soil is 2.24 g/cc for the soil with 5% replacement with RHA.
- The RHA replacement in silty soil affects the compaction characteristics. The dry density value decreases with increase in the RHA inclusion since RHA is possessing more fine particles.
- The shear strength of the soil increases with the increase in percentage of rice husk ash and it can be extended to various percentages to know the optimum value.
- The CBR value of the soil also increase as the rice husk ash is added. The mixing of ash becomes difficult when the percentage of ash increases due to separation of ashes from the mixture.
- This study can be extended with lime or cement to study the soil modification when it combines with the Rice husk ash.
- Soil Modification results in the reduction of moisture,alters the final usage of soil structures and finally cost reduction.

REFERENCES

[1] Anurag Gangwar, Anoopsingh Chandel"Effect of Rice Husk ash on the Shear Strength Parameters of Silty Sand". International Journal of Science & Research, Vol.6,Issue 7 (2017).

[2] Chore.H.S,KumtheA.A,Abnave.S.B,Shinde.S.S,Dhole.S.S&Kamerkar.S.G"Performance evaluation of Polypropylene fibers on Sand-Flyash mixtures in Highways", Journal of Civil Engineering (IEB), 39(1)(2011) pg.91-102.

[3] Mousa F Attom,Adil K.Al-Tamini"Effects of polypropylene fibers on the shear strength of sandy soil", International Journal of Geo Sciences (2010) pg.44-50.

[4] Ndepete, C.P., S. Sert "Use of Basalt Fibers for Soil Improvement". "International Conference on Computational and Experimental Science and Engineering" vol.130 (2016) pg.355&356.

[5] Pravin Patel, Dr. Mahiyar .H .K "A Experimental Study of Black Cotton Soil, Stabilized with Rice Husk Ash, Fly Ash and Lime" ,International Journal of Engineering Research & Technology, (2014),Vol. 3, Issue 11, pg. 660-665.

[6] Tiwari.S.K & Sharma.J.P. "Influence of fiber reinforcement on CBR value of Sand." EJCE, Vol 8(2013),pg 4303-4311.

[7] Nadhirah Mohd. Zambri, Zuhayr Md. Ghazaly "Peat soil stabilization using Lime and Cement."E3S Web of Conferences,34,01304(2018).