International Journal of Engineering Research and Development
e-ISSN: 2278-067X, p-ISSN: 2278-800X, www.ijerd.com
Volume 9, Issue 11 (February 2014), PP.44-49

Effect of Rice Husk on Soil Properties

Anniamma Chacko[1], Nikhil Roy[2] ,Mercy Joseph Poweth[3]
[1]*Professor, ,M.A. College of Engineering, Kothamangalam.*
[2]*Student, Department of Civil Engineering. M.A. College of Engineering, Kothamangalam*
[3]*Professor, M.A. College of Engineering,Kothamangalam*

Abstract:- Rice Husk is a waste material produced in rice industry. For every 1000 Kg of paddy milled, about 220Kg of husk is produced. Rice Husk can be used in various geotechnical constructions like embankments, soil stabilization, and sub grades etc.

Keywords:- Rice husk, optimum moisture content, shear strength, cohesion, angle of internal friction

I. INTRODUCTION

Reinforcement of soil using fibers has been a subject of research for a long time. The concept of reinforcing soil with tensile resisting element has been widely accepted in engineering practice. In many developing countries there is a need to probe more into the potentials of laterite soils as a reliable and durable construction material as it is locally available and has been one of the major building materials for a long time. Admixtures are ingredients other than water, aggregates, hydraulic cement, and fibers that are added to the soil to enhance its properties. A proper use of admixtures offers certain beneficial effects to soil, including improved quality, strength development etc. Admixtures vary widely in chemical composition, and many perform more than one function. Tests should be made to evaluate how the admixture will affect the properties of the soil. Examples of additives include Portland cement, lime, fly ash, bitumen, and any combination of cement, lime, and fly ash.

In comparison to systematically reinforced soil, randomly distributed fiber reinforced soils exhibit some advantages. Preparation is similar to soil stabilization by admixture. Discrete fibers are added and mixed with soil like other additives. Randomly distributed fibers offer strength isotropy and limit potential planes of weakness that can develop parallel to oriented reinforcement in systematically reinforced soils. The use of natural materials such as jute, cotton, coir, sisal etc. as reinforcing materials in soil started in the early nineties'. The main advantage of these materials is that they are locally available with practically little cost. They are biodegradable and hence will not create environmental problems. This ability of natural fibers to absorb water and to degrade with time is its prime property which gives them an edge over the synthetic materials. In this work, an attempt has been made to utilize agricultural waste like rice husk as a soil-stabilizing agent. The strength behaviour of the local soil reinforced with randomly included husk is studied in detail.

II. MATERIALS AND METHODS

The soil samples were collected from Kothamangalam (Kerala, India). The Rice Husk samples were collected from three different mills namely Kalady, Ramamangalam and Thattekkad. The geotechnical properties of the soil samples were tested as per Indian Standard Specifications and are shown in Table 1.

Table 1- Properties of Soil

Property	Soil sample
Specific gravity	2.44
Liquid limit (%)	48
Plastic limit (%)	33.33
Plasticity index (%)	14.67
Maximum dry density (%)	1.67
Optimum moisture content%	21
Cohesion(kN/m^2)	44
Angle of internal friction	4^0
Effective size(μ)	320
Uniformity coefficient	11.25
Coefficient of curvature	0.868

The specific gravity of rice husk samples are listed in Table 2

Table 2 specific gravity of rice husk

Sample	Specific Gravity
Sample 1	1.25
Sample 2	1.11
Sample 3	1.13

Rice Husk sample 1 was selected for the tests. Rice Husk was added to soil in various percentages (0%, 10%, 15% and 20%).Tests like Proctor's Compaction, Consistency Limits and Direct Shear Test were performed to evaluate the variation of strength with addition of Rice Husk.

III. RESULTS AND DISCUSSIONS

1. Consistency limits

1.1 Liquid Limit

The Liquid Limit was found out by using Casagrande apparatus and the test is conducted as per IS 2720: Part V: 1970. The variation of Liquid Limit with percentage of husk is shown in Figure 1

Table 3 Consistency limit

%Husk added to soil	Liquid limit (w_L in %)	Plastic limit (w_P in %)	Plasticity Index (I_P in %)
0	48	33.33	14.67
10	38	26.21	11.79
15	42	32.9	9.1
20	45	38.49	6.51

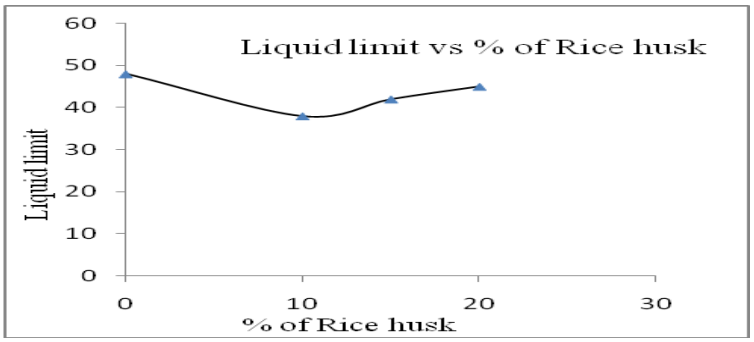

Fig: 1 Liquid limit vs. % of Rice husk

Liquid limit first showed a decreasing trend with increase in rice husk and a minimum value was obtained 10 and 15%.Then liquid limit increases with % of husk.

1.2 Plastic Limit

Figure 2 shows the relationship between plastic limit and % of Rice husk. The trend is similar to that of the liquid limit.

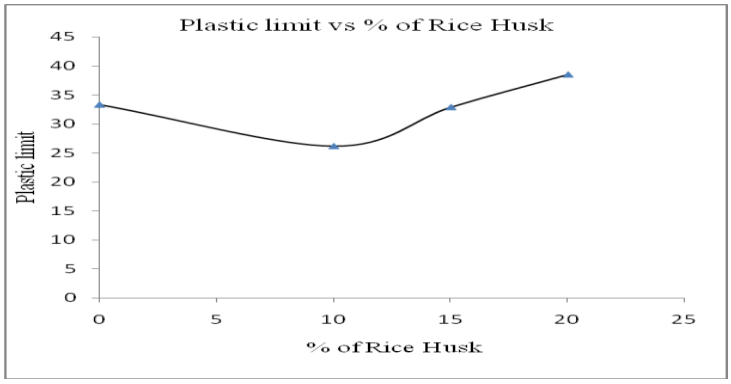

Fig: 2 Plastic limit vs. % of Rice husk

1.3 Plasticity Index

Figure 3 shows the relationship between plastic limit and % of Rice husk. Plasticity index decreases with increase in % of rice husk.

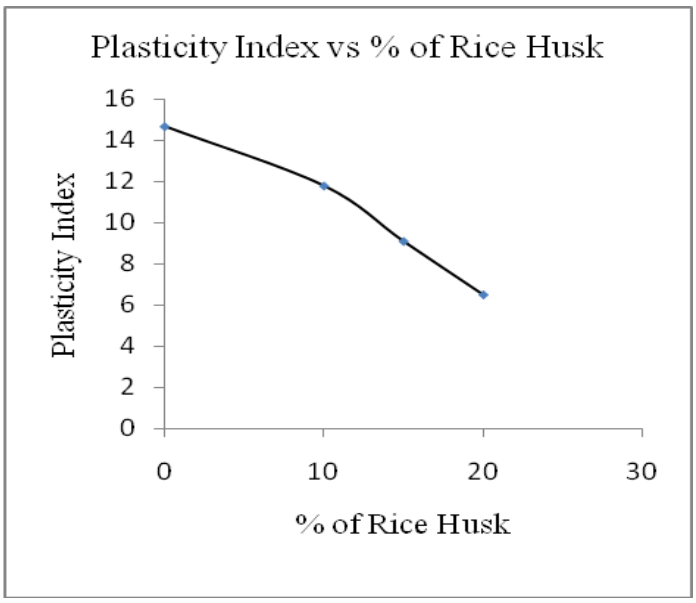

Fig: 3 Plasticity index vs. % of rice husk

2. Compaction Test

Results of compaction test are tabulated inTable4 Table 4 Compaction test

% husk added to soil	Optimum moisture content (OMC in %)	Maximum dry density (MDD in g/cc)
0	**21**	**1.67**
10	**25.3**	**1.44**
15	**32.3**	**1.32**
20	**40**	**1.16**

Figure 4 shows the relationship between the MDD and Rice husk. The results indicates that between 0 % to 20 % Rice husks, the MDD reduces from 1.67 g/cc to 1.16 g/cc respectively.

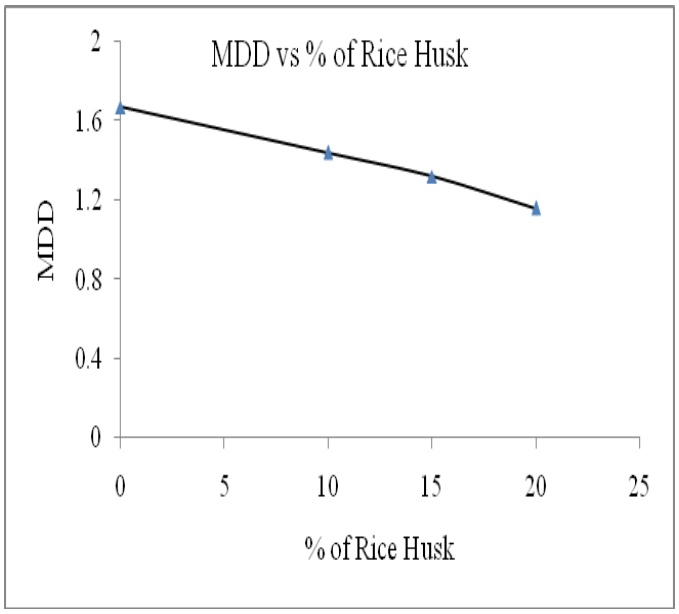

Fig 4 MDD vs. % of rice husk

Figure 5 shows variation of OMC with Rice husk. The result shows that the OMC increased with increase in % of Rice husk.

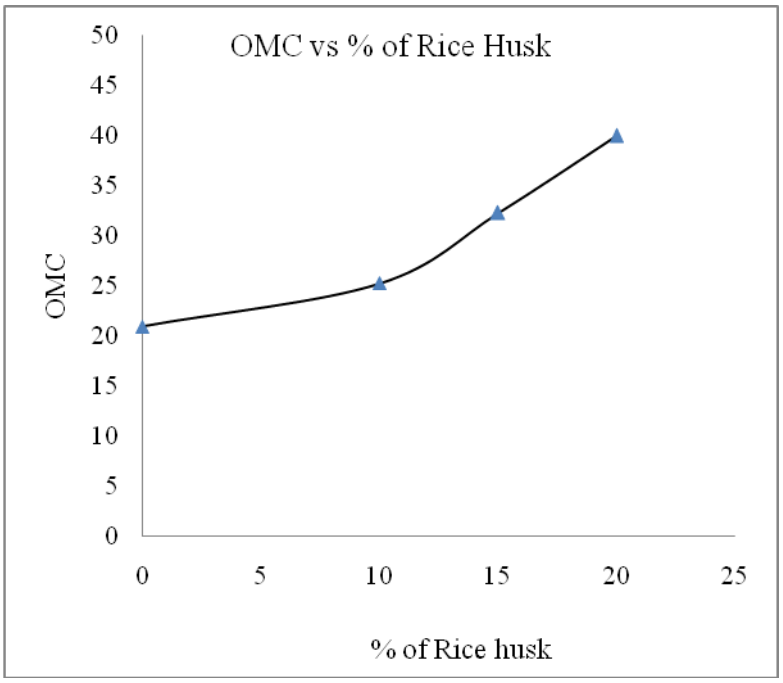

Fig 5 OMC vs. % of rice husk

3. Direct Shear Test

The Direct Shear Test was conducted to find out the shear strength. The results are tabulated in Table 5.

Table 5 Direct shear Test

% husk added to soil	Cohesion (C in kg/cm^2)	Angle of internal friction (Φ)
0	0.44	4.883^0
10	0.39	6.6^0
15	0.28	9.916^0
20	0.15	11.3^0

The given Figures 6, 7 & 8 show the variations of Cohesion, Angle of internal friction and Shear Stress with percentage of rice husk. From the Cohesion -%rice husk graph, we can see that with increase in % of husk cohesion decreased. It may be attributed to the coating of the soil by the Rice husk.

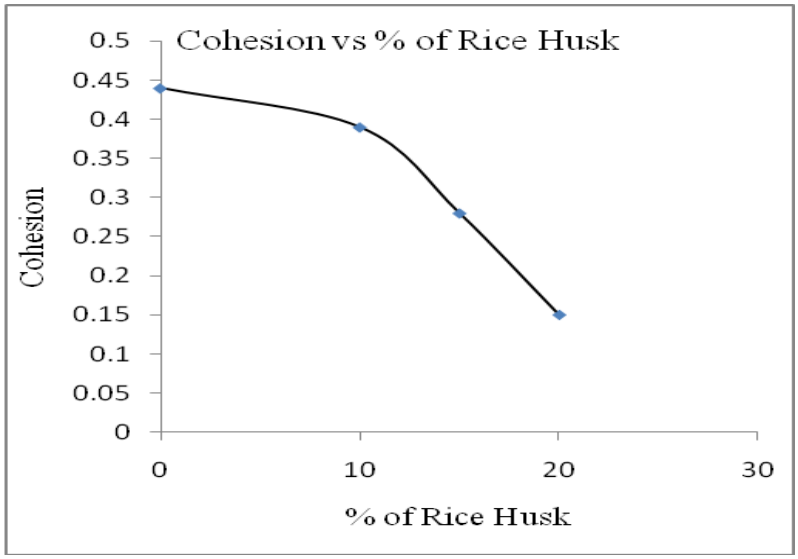

Fig 6 Cohesion vs % of rice husk

From the Angle of internal friction-%rice husk graph we can see that with increase in % of husk Angle of internal friction increased. This indicates that the friction between the particles increases. This may be due to the coating of the soil by Rice Husk, which resulted in larger particles and hence greater friction between them.

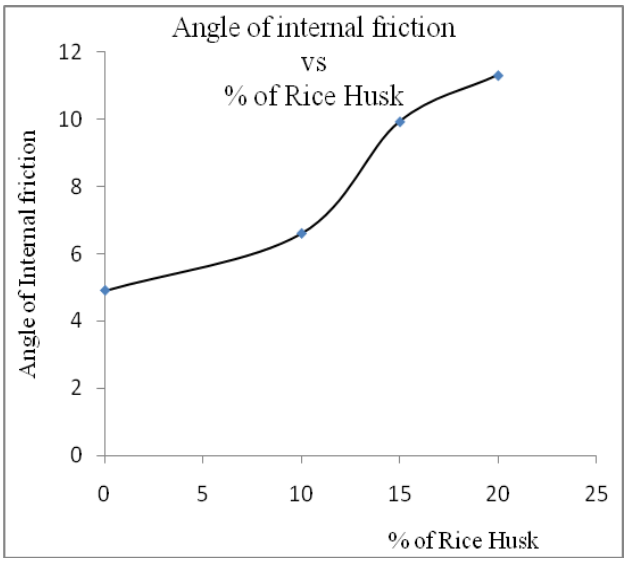

Fig 7 Angle of internal friction vs. % of rice husk

By using the Mohr-Coulomb's equation, the shear strength was calculated. It was found that with increase in % rice husk the shear strength increased. There is a slight dip in the graph a rice husk of 20%.The optimum value of shear strength was around 15%.

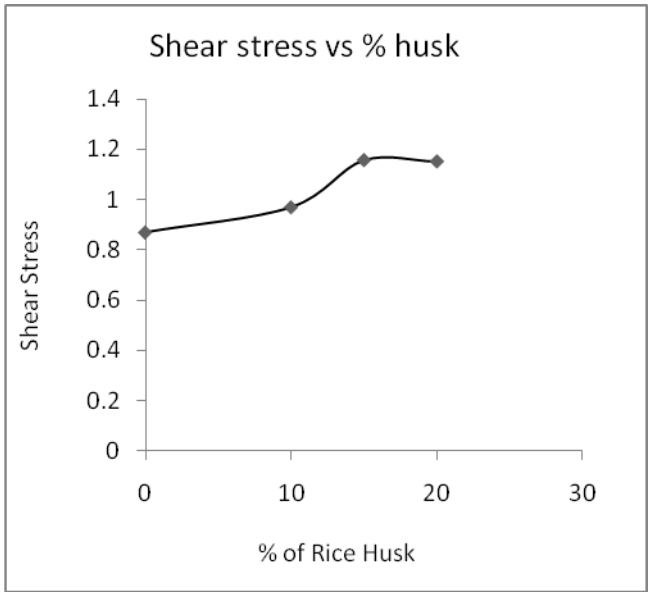

Fig 8 Shear Stress vs. % of rice husk

V. CONCLUSION

The effect of Rice Husk on the soil sample was studied by conducting tests like Consistency Limits, Proctor's Compaction and Direct Shear Test with various percentages .It was found that the strength increases with increase in Rice Husk content, reaches a maximum value and thereafter decreases. The optimum Rice Husk content was found to be in the range 15-20%.

Based on the test results it can be concluded that substantial quantity of Rice Husk improves the soil properties. Hence Rice Husk can be used in slopes for temporary stabilization. It stabilizes the soil initially when the seeds are planted. In later stages, when the husk degrades it act as manure for the growth of plants and also makes the soil airy which result in less runoff during heavy rains.

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