Soil Stabilization of Clayey Soil using Rice Husk Ash and Polypropylene Fiber

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Abstract :It has become an utmost important to make soil fit to bear the heavy load coming from modern infrastructures and highways,. All the pre available soils, sometimes, are not fit to withstand heavy loads as they have weak strength due to more cohesion/ swelling properties or very densely packed particles. Therefore, the exploration of soil properties before and after its stabilization is needed. In current experimental program, raw soil was collected and its stabilization was carried out with the help of rice husk ash and PP fibres. Various strength and other engineering parameters were determined in laboratory but only physical properties of RHA and PP fibres were explored during this study. Therefore, from the various results obtained from different laboratory tests, it is concluded that the optimum percentage of RHA and PP fibres are 9% and 0.2% respectively as at this proportions best results were attained. So, it is highly recommended that 9% Rice husk ash and 0.2% PP fibres of waste materials by dry weight of soil should be utilized for enhancing the different properties of raw soil.

IndexTerms **- Soil Stabilization, Rice Husk Ash, Polypropylene fibres.**

I. INTRODUCTION

Soil Stabilization is the process which alters the soil in order to improve their physical properties and gives stability. This process can enhance the shear strength of a soil and/or control the shrink-swell properties of a soil i.e. compaction or consolidation, which ultimately improves the load bearing capacity of a sub-grade which easily support pavements and foundations. Soil Stabilization process may be used for construction of roadways, parking areas, projects which entails development of site, runways or terminals for airports and any other similar situations where sub-soils are not feasible for erection of structure. Stabilization process is being used to treat the wide range of sub-grade soils, which varies from expansive clays to granular materials.

Rice husk ash (RHA) is a waste and end product of rice milling industry. It is used as a soil stabilizer or as a replacement to cement, is an alternative to the final disposition with environmental benefits. Due to its non-self-cementitious properties, a hydraulic binder like a lime or cement must be added to form cementitious slurry in order to improve the soil strength. Researches on stabilization by the application of RHA and cementitious material combinations were conducted in various kinds of soils.

The polypropylene is a 100% synthetic fibre which is made from 85% propylene as the monomer of PP is propylene and it is the end product of petroleum. Polypropylene chips are transformed to polypropylene PP fibres with the help of melt spinning. It's a traditional method. Structurally, PP fibres are composed of crystalline and non-crystalline regions. The fibres are available in different sizes ranging from just a fraction of millimetre to centimetres in diameter.

[1] OBJECTIVES OF THE STUDY

1. To study the geotechnical properties of the soil sample collected from the site.
2. To stabilize the soil by using Rice Husk Ash at proportion of 3%, 6% and 9% and PP fibres at varying proportion of 0.1%, 0.2% and 0.3%.
3. To study the change in properties like OMC, Dry density, CBR with different proportions of Rice Husk Ash and PP fibres.
4. To analysis and compare the obtained results and suggest the optimum percentage of Rice Husk Ash and PP fibres for stabilizing the soil.

[2] RESULTS

Various outcomes of different tests conducted on raw soil recovered from the soil have been represented in tabular form given below:

Table 1: Results of Tests Carried Out on Raw Soil Sample

S. No.	Test Name	Parameters Determined (Value)			
1	Determination of Atterberg Limits	Liquid Limit	37.2%	Plastic Limit	26.61%
2	Standard Proctor Test Apparatus	(MDD)	1.95g/cc	(OMC)	15%
3	Direct Shear Test	Cohesion Factor (c)	0.715 Kg/cm2	Angle of Internal Friction (φ)	8° 2'
4	Plasticity of Soil	Plasticity Index(PI)		10.59	
5	C.B.R value	3.8%			
6	Percentage Finer	51.5%			
7	Type of Soil	CI			
8	Specific Gravity	2.68			

Standard Proctor Test Results

The final results of Standard Proctor Test performed on raw and stabilized soil are represented in the following table.

Table 2: Values of MDD and OMC for various soil samples.

Sr. No.	Soil Type	MDD (γd)g/cc	OMC, (w)%
1.	Untreated Soil	1.95	15
2.	Soil with 3% RHA	1.92	13.5
3.	Soil with 6% RHA	1.85	16.5
4.	Soil with 9% RHA	1.82	17.2
5.	Soil with 9% RHA + 0.1% PP Fibres	1.81	18
6.	Soil with 9% RHA + 0.2% PP Fibres	1.72	18.5
7.	Soil with 9% RHA + 0.3% PP Fibres	1.68	19.3

From the above table, it can be concluded that, raw soil has MDD of 1.95 g/cc at 15% as its OMC. After adding RHA and PP fibres, MDD starts to decrease till the end.

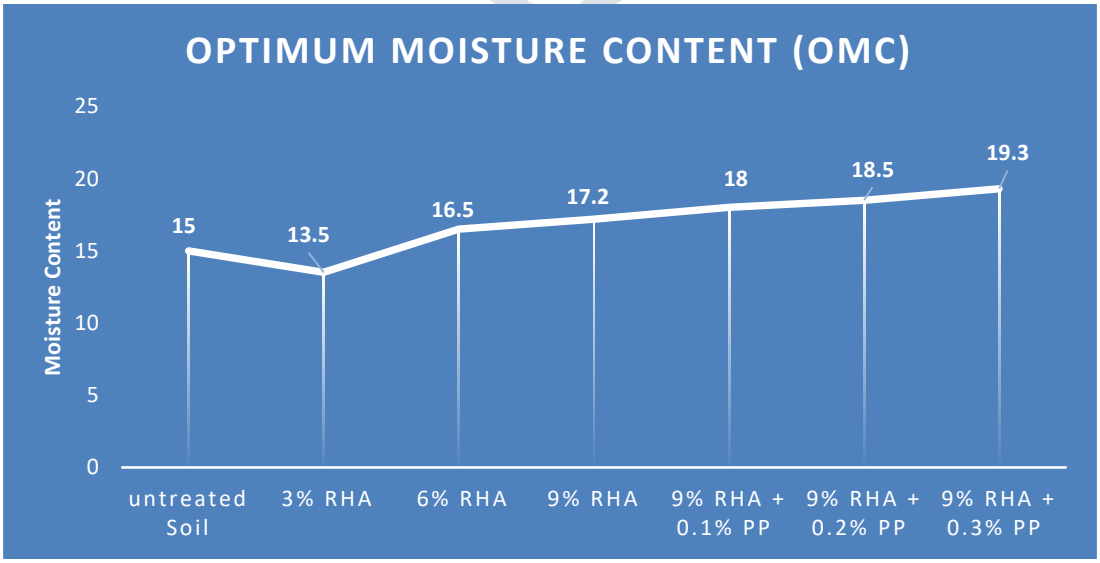

Figure 1: OMC of Various Soil Samples.

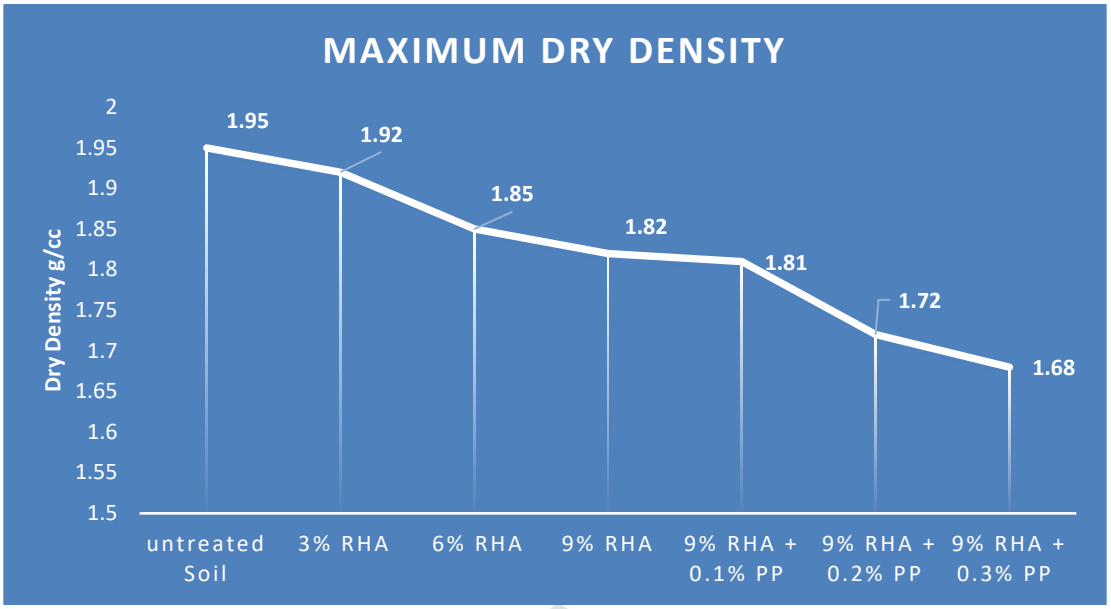

Figure 2. MDD of Various Soil Samples.

CBR Test Results

The final results of CBR Test performed on raw and stabilized soil are represented in the following table.

Table 3: CBR values of various soil samples.

Sr. No.	Soil Type	CBR %
1.	Untreated Soil	3.79
2.	Soil with 3% RHA	4.24
3.	Soil with 6% RHA	4.61
4.	Soil with 9% RHA	5.28
5.	Soil with 9% RHA + 0.1% PP Fibres	5.61
6.	Soil with 9% RHA + 0.2% PP Fibres	7.49
7.	Soil with 9% RHA + 0.3% PP Fibres	6.95

From the above table, it can be concluded by scrutinizing the results of CBR test, Soil with 9% RHA + 0.2% PP Fibres gives the maximum CBR value of 7.49%.

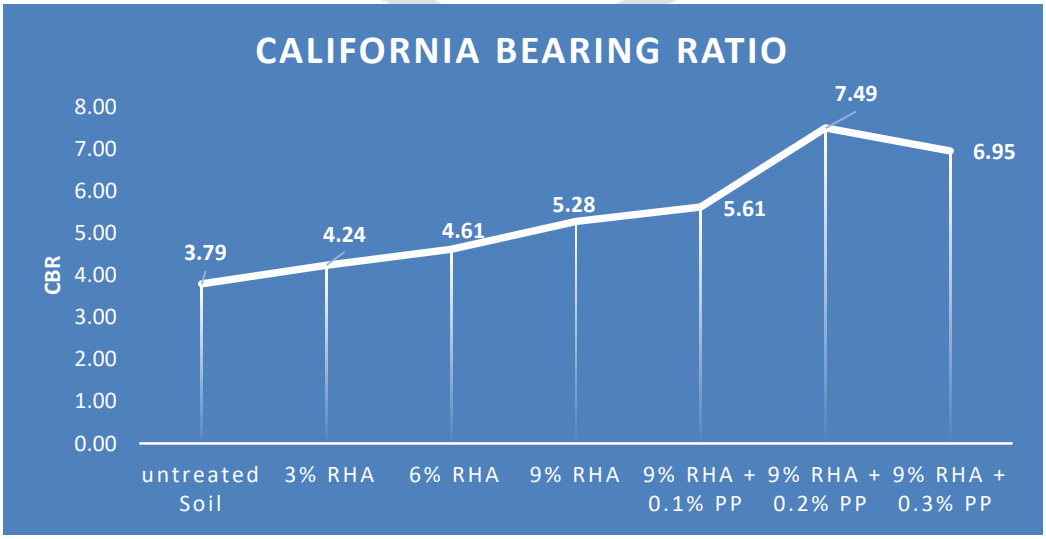

Figure 3. CBR Values of Various Soil Samples.

Direct Shear Test

The final results of Direct Shear Test performed on raw and stabilized soil are represented in the following table.

Table 4: Results of Direct shear test for various soil samples.

Sr. No.	Soil Type	Cohesion (kg/cm2)	Angle of internal friction (φ)
1.	Untreated Soil	0.7150	8° 2'
2.	Soil with 3% RHA	0.6737	9° 49'
3.	Soil with 6% RHA	0.6670	12° 8'
4.	Soil with 9% RHA	0.6463	17° 41'
5.	Soil with 9% RHA + 0.1% PP Fibres	0.7147	14° 18'
6.	Soil with 9% RHA + 0.2% PP Fibres	0.7333	18° 31'
7.	Soil with 9% RHA + 0.3% PP Fibres	0.6997	16° 39'

The value of cohesion has decreased with the addition of RHA, and then it increases with the addition of PP fibres till 0.2% and then again, it decreases. But the value of frictional angle increased in all the cases but in the end it decreases with the addition of 9% RHA and 0.3% PP fibres.

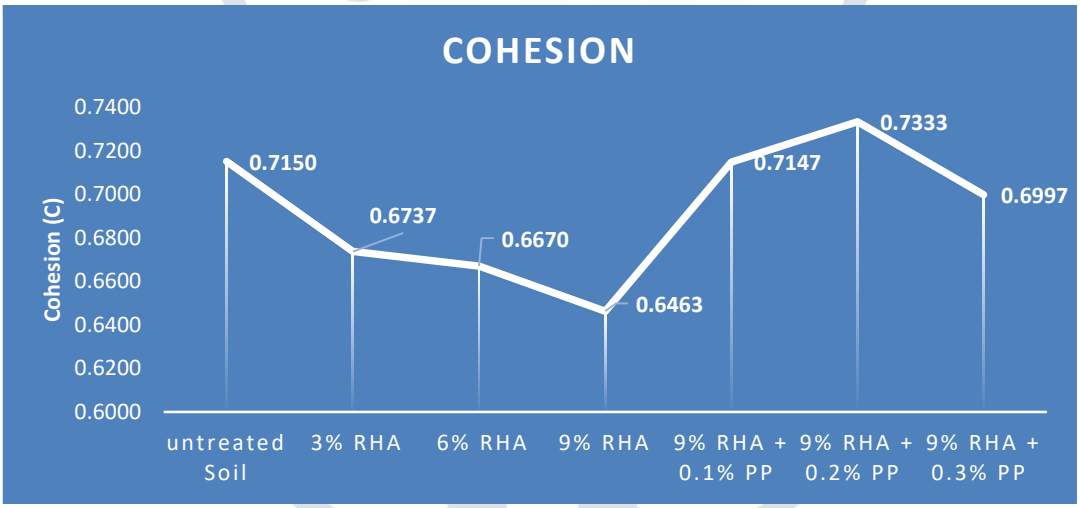

Figure 4. Cohesion of Various Soil Samples.

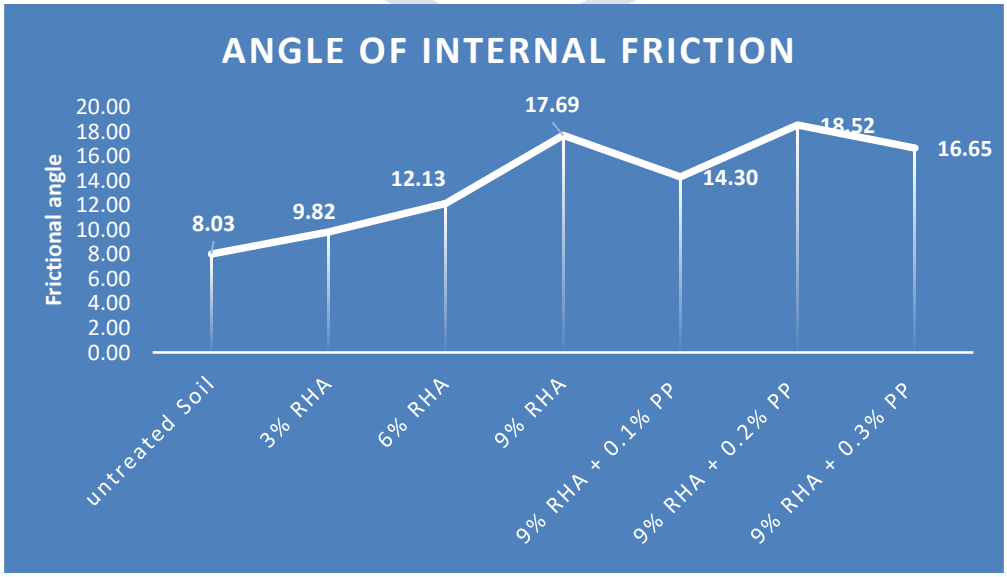

Figure 5. Angle of Internal Friction of Various Soil Samples.

3 CONCLUSIONS

All the laboratory tests have been conducted as per the codal guidelines and the results were recorded and studied. The final conclusions were then made which are mentioned below:

1. The values of Optimum Moisture Content (OMC) and Maximum Dry Density obtained for the raw soil from standard proctor test were 15% and 1.95 g/cc respectively.
2. From the results of soil having RHA, it was found that maximum dry density decreases as the percentage of RHA increases from 3% to 9%. The same criteria were seen when the Percentage of PP fibres increases from 0.1% to 0.3%.
3. In comparison to raw soil, the soil mixed with 9% RHA gave the maximum CBR value from all the soil samples containing RHA i.e. 5.6%, almost 40% increase in the value. Therefore, this proportion of RHA was fixed for further investigation and to analyse the combine effect of RHA and PP fibres on soil.
4. The soil containing fixed proportion of RHA i.e. 9% and varying proportion of PP fibres has shown enhanced results of CBR test but the maximum CBR values was attained at 0.2% of PP fibres i.e. 7.5%. Therefore, the optimized proportion of RHA and PP fibres are 9% and 0.2%.
5. The CBR value of this soil is almost twice the CBR value of raw soil whereas, in comparison to soil containing only RHA (9%), the CBR value of soil (9% RHA and 0.2% PP fibres) has an increase of 42%.
6. The cohesion and angle of internal friction of raw soil comes out to be 0.715 kg/cm2 and 8° 2’ respectively.
7. The results of direct shear test were studied and it was noticed that after mixing the RHA to the soil at different proportions, the cohesion value starts to decrease from 0.715 kg/cm2 to 0.6463 kg/cm2, whereas, the angle of internal friction starts to increase from 8° 2’ to 17° 41’. But the after analysing the effect of PP fibres, it was noticed that, the cohesion value and angle of internal friction increases as the % of PP fibres increases till 0.2% and then slightly decreases. Maximum cohesion and angle of internal friction was attained for the soil containing 9% RHA and 0.2% PP fibres i.e. 0.715 kg/cm2 and 18° 31’ respectively.
8. Overall gain of 42% of CBR thickness of subgrade reduced to around 50 mm in rural roads of traffic parameter T1 as per IRC:SP72-2007 that will reduce the cost of rural roads.

Therefore, it can be concluded that the present experimental study gives the satisfactory results by improving the existing soil.

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