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Stabilization of cohesive soil using rice husk ash and polypropylene fibers

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Abstract

Soil is very significant in civil engineering construction. Soil having poor engineering properties may create many problems. To make the soil suitable for the desired level of construction, it is necessary to augment the engineering characteristics of soil. There are various methods of improving the engineering properties of soil. The soil stabilization technique is one of the most effective tools used now days for enhancing the engineering properties of soil. But the soil stabilization is becoming costly day by day due to the rise in cost of stabilizing agent like cement, lime etc.

On the other hand large quantity of waste material produced from the different industries like fly-ash, rice husk ash, plastic waste, paper mill slag etc. create negative impact on the environment causing environmental pollution and hence safe disposal of these waste material is required. Utilized these waste material as stabilizing agent for improving engineering properties of poor soil is best solution and also using these waste material as a stabilizing agent not only solve the dumping issue but as well as minimize the expenditure of stabilization.

In this research work, an extensive laboratory work have been done to explore the use of local available RHA as agricultural waste and waste fibres of the polypropylene for the improvement of the various properties of the Clayey (CI) type of soil obtained from proposed site of D.A.V. public school (junior wing) behind cloth market Ambala City, Haryana (India).The objective of this work to explore the effect of waste fiber of polypropylene in different length i.e. 10mm, 20mm, 30mm and different percentage i.e. 0.20%, 0.30%,0.40% as reinforcement mixed with optimum amount of RHA stabilized soil. The effect on engineering characteristics of clayey soil as well as RHA stabilized Reinforced soil such as Maximum Dry Density, Optimum Moisture Content, Shear Parameter, Unconfined Compressive strength was investigate.

Keywords: stabilization, cohesive soil, rice husk ash, polypropylene fibers

Introduction

Soil is very essential constituent in civil engineering construction. The characteristics of soil are co-related with the loading and drainage condition and vary in all direction. Behavior of soil mainly depends upon its type and its composition. So, it is necessary that the soil should have good engineering characteristics for its adequate strength otherwise it creates many problems.

It is always more important to know engineering properties of soil for any Civil Engineering project. While selecting any suitable site for a particular project, earlier there were limited options like if site has not suitable soil then engineers needed to adopt alternatives for foundations for example deep foundation or required to change the location or nature of project accordingly. But now a day, the scenario has been changed. With the help of soil stabilization techniques any soil can be improved at any desired bearing capacity.

In India, soil stabilization became popular after 1970. After 1970 Indian engineers worked on it and the technique used in several projects. It all became possible because of soil stabilization technique has proved to be cost effective since it improves all the related parameter of soil which makes it cost effective for better utilization for the purpose it is involved.

2. Material used

2.1 Soil

Sample were brought from the proposed site of D.A.V. school (junior wing) opposite cloth market Ambala city**.** Standard test were performed to determine theindex and engineering property of soil. Detail are given below in Table- 1and soil had been categorized as CI type soil.

Table 1: Categorization of Soil Depending on the Index Properties

Sr. No.	Characteristics of the Soil Sample	Results
1.	Liquid Limit	49.0%
2.	Plastic Limit	25.0%
3.	Plasticity Index (PI)	24.0
4.	Type of Soil as per IS: 1498	CI
5.	Specific Gravity (G)	2.743

Table 2: Evaluated Values of Engineering Properties of the Plain Soil

Sr. No.	Engineering Property of the Plain Soil Sample	Evaluated Value of Engineering Property
1.	Compaction Characteristics	
	i) Maximum Dry Density, ($\Upsilon_{d(max)}$)	18.67 kN/m^3
	ii) Optimum Water Content, (*w*)	14.80 %
2.	Shear Parameter	
	i) Angle of Shearing Resistance (Φ)	20.30°
	ii) Cohesion (c)	50.51 kN/m^2
3.	Unconfined Compressive Strength, (UCS)	356.72 kN/m^2

2.2 Rice husk ash

During the milling of paddy in rice milling factory huge amount of rice husk is produced. The word wide production of rice husk is about 650 million tons. When husk is burned in boiler it generates ash which is about 25%by weight of husk. Its nature is non plastic and it has good pozzolanic property. The main constituent of RHA is silica, alumina, iron oxide, calcium, sodium and potassium.

The experiment was conducted on clayey soil stabilized with 3%, 6%,9%, and 12% of RHA by weight of dry soil sample and the effect of RHA was examine to calculate the optimal amount of RHA accordingly.

2.3 Polypropyle

Propylene was discovered in 1954 by the process of polymerization resulting to a crystalline isotactic polymer due to the efforts of the Italian chemist Giulio Natta and the German chemist Karl Rehn. In 1957, an Italian company started production of this polymer on mass scale following the discovery. Later, Natta and his team also discovered syndiotactic polypropylene

3. Objectives of the study

The objective of the present study is

1. To find optimum dose of RHA for clayey soil by unconfined compressive strength test.
2. To find the optimum dose and optimum fiber length for clayey soil with optimum dose of RHA by unconfined compressive strength test.
3. To find the optimum dose and optimum fiber length for clayey soil with optimum dose of RHA by shear strength test.

4. Experimental methodology

The experimental methodology selected to complete this research work is described below

1. Test to be been performed on plain soil to determine the compaction characteristics, unconfined compressive strength and shear parameter.
2. Test to be performed on soil mixed with varying % age of RHA such as unconfined compressive strength test for optimization of RHA and shear parameter test
3. Test to be performed on optimum dose of RHA stabilized soil reinforced with PP of 10mm, 20mm, 30mm length and 0.2%, 0.3% and 0.4% by weight of Dry soil sample to determine the compaction characteristics, unconfined compressive strength and shear parameter

5. Experimental investigations and result

5.1 Compaction Test

In this research work Compaction Characteristics of plain soil, varying %age i.e. 3%,6%,95,12% of RHA stabilizes soil and optimum dose of RHA stabilized soil reinforced with PP have been determined by modified proctor's.

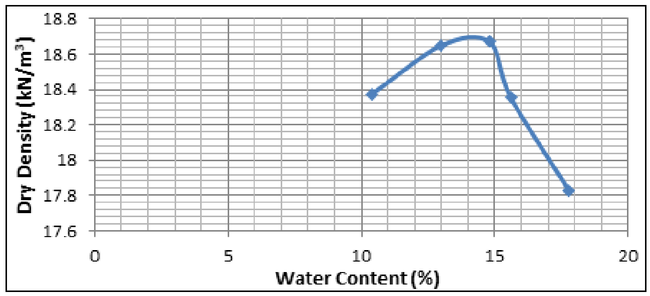

Fig 1: Compaction Curve for Plain Soil Sample

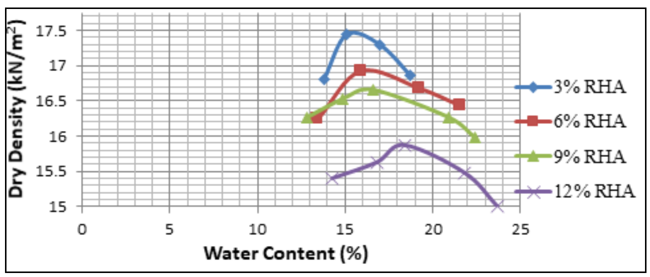

Fig 2: Compaction Curve for Plain Soil Sample Stabilized with RHA

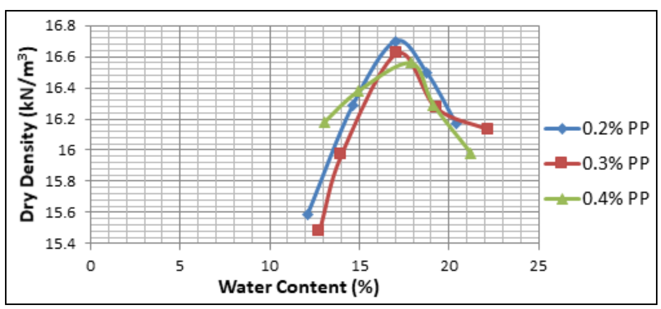

Fig 3: Compaction Curve of RHA Stabilized Sample Reinforced with 10mm length of PP

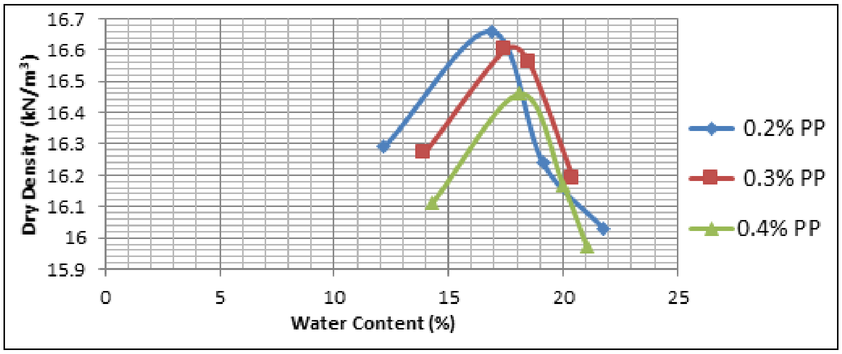

Fig 4: Compaction Curve of RHA Stabilized Sample Reinforced with 20mm length of PP

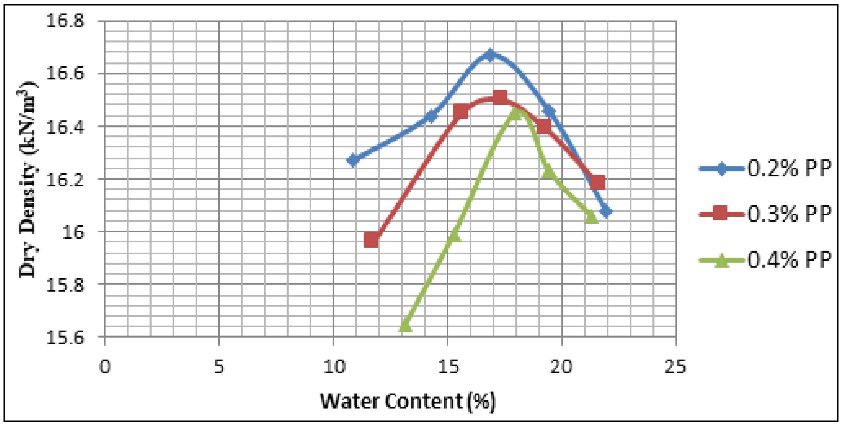

Fig 5: Compaction Curve of RHA Stabilized Sample Reinforced with 30mm length of PP

Table 3: Value of MDD-OMC of plain soil, optimum dose of RHA stabilized soil and RHA stabilized soil reinforced with PP of difference length and %age

Sr. No	Clay Soil		9%RHA Stabilized		Percentage of PP = 0.20% and 9% RHA		Percentage of PP = 0.30% and 9% RHA		Percentage of PP = 0.40% and 9% RHA	
	MDD (kN/m³)	OMC (%)	MDD (kN/m³)	OMC (%)	MDD (kN/m³)	OMC (%)	MDD (kN/m³)	OMC (%)	MDD (kN/m³)	OMC (%)
1.	18.67	14.8	16.66	16.6	Length of PP = 10 mm					
					16.70	17.00	16.62	17.09	16.56	17.88
2.					Length of PP = 20 mm					
					16.66	16.86	16.60	17.46	16.46	18.11
3.					Length of PP = 30 mm					
					16.67	16.89	16.50	17.39	16.45	17.78

5.2 Unconfined Compressive Strength

In this study U.C.S. test have been performed on plain soil, 3%, 6%, 9%, and 12% RHA stabilized soil for finding out the optimum dose of RHA and also on RHA stabilized soil reinforced with varying %age and length of PP**.**

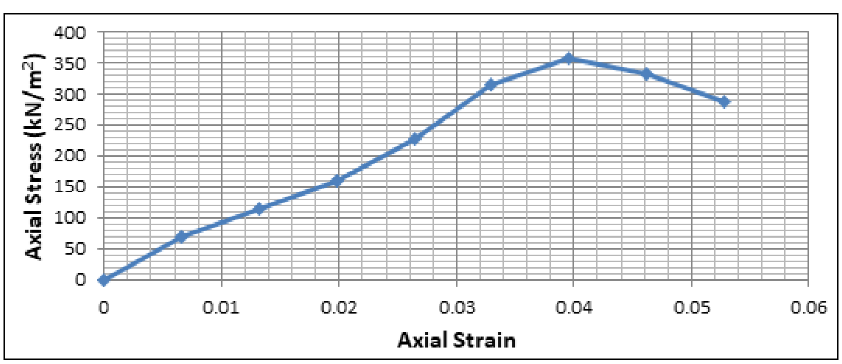

Fig 6: Stress Vs Strain Curve for UCS of Plain Soil Sample

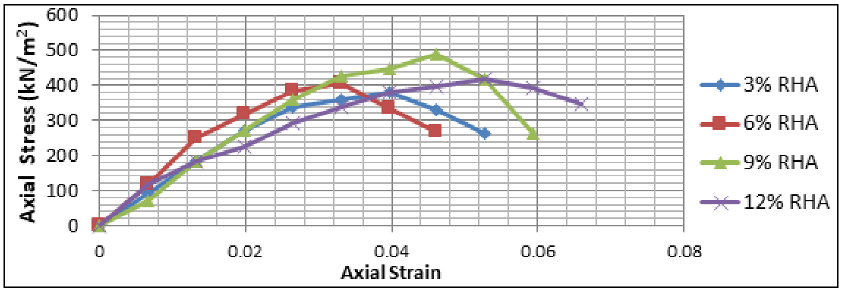

Fig 7: Stress Vs Strain Curve for UCS of 3%, 6%, 9% &12% RHA Stabilized Soil

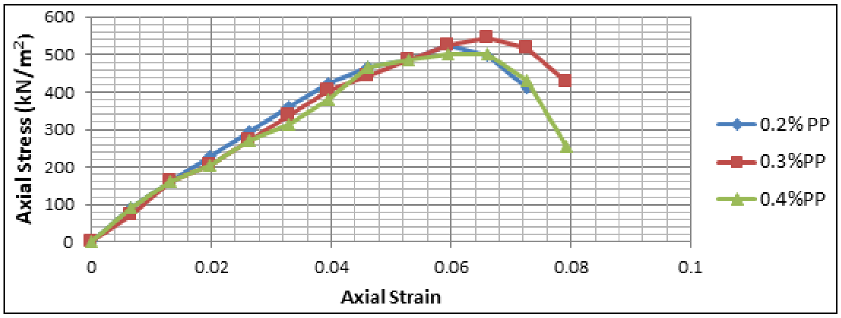

Fig 8: Stress Vs Strain Curve for UCS of RHA Stabilized Soil Reinforced with 10mm LengthPP

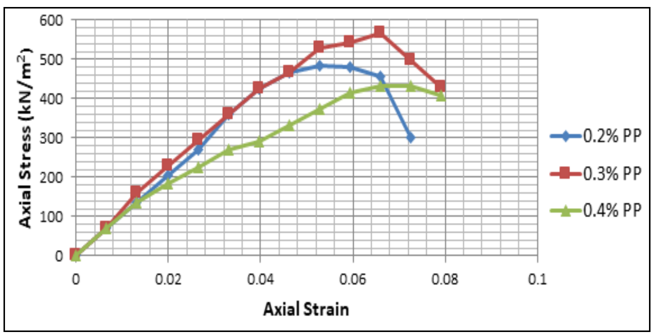

Fig 9: Stress Vs Strain Curve for UCS of RHA Stabilized Soil Reinforced with 20mm length PP

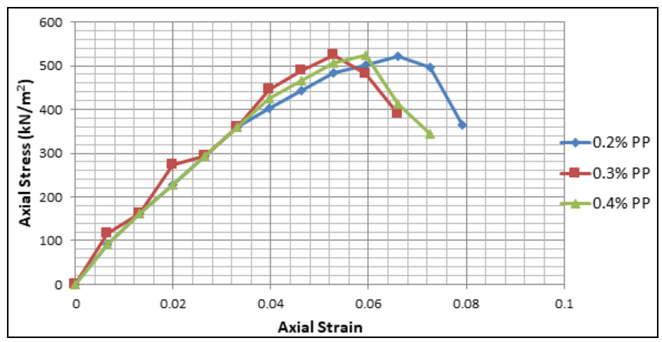

Fig 10: Stress Vs Strain Curve for UCS of RHA Stabilized Soil Reinforced with 30mm length PP

Table 4: Result of UCS Test

Sr. No.	%age of (Clay +RHA+PP)	Length of PP		
		10mm	20mm	30mm
		value of UCS (kN/m²)		
1	100%+0%+0%	356.72		
2	91%+9%+0%	488.04		
3	90.8%+9%+.2%	525.28	484.12	521.36
4	90.7%+9%+.3%	542.92	568.40	525.28
5	90.6%+9%+.4%	502.74	434.14	525.28

Table 5: Comparisons of Increase in UCS of 9% RHA Stabilized Reinforced Soil with Plain Soil

Sr. No.	Proportion of Soil, RHA and PP in Percentage (Soil +RHA+PP)	Length of PP		
		Increase in UCS of Soil		
		10mm	20mm	30mm
1.	100%+0%+0%	356.72 kN/m²		
2.	91%+9%+0%	488.04kN/m² (36.81 %)		
3.	90.8%+9%+0.20%	47.26%	35.71%	46.15%
4.	90.7%+9%+0.30%	52.20%	59.34%	47.25%
5.	90.6%+9%+0.40%	40.93%	21.70%	47.25%

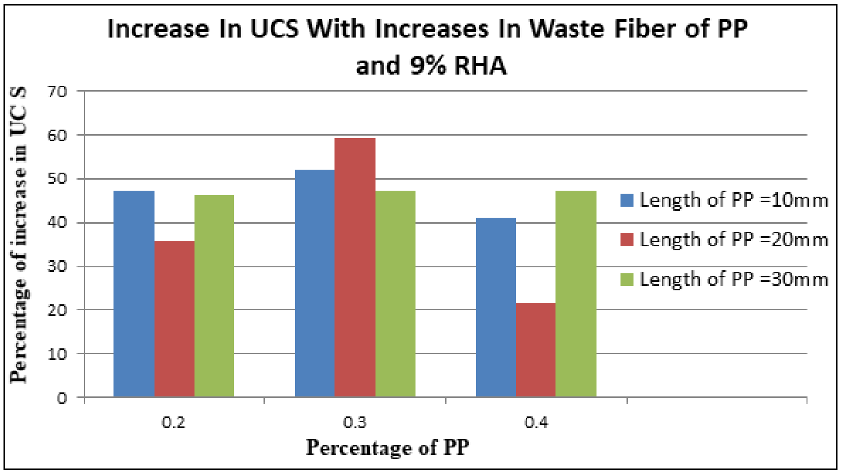

Fig 11: Increase in UCS with the Increase in Waste Fibres of PP And 9%RHA

Table 6: Values of Shear Parameters of clayey soil and 9% RHA Stabilized Soil Reinforced with PP

Sr. No.	Percentage of (clay +RHA+PP)	Length of PP					
		10mm	20mm	30mm	10mm	20mm	30mm
		Angle of Shearing Resistance(Φ)			Cohesion c (kN/m^2)		
1.	100%+0%+0%	20.30°			50.51 kN/m^2		
2.	91%+9%+0%	24.70°			38.71 kN/m^2		
3.	90.8%+9%+0.20%	32.70°	30.11°	30.11°	60.76	57.33	50.96
4.	90.7%+9%+0.30%	32.62°	33.34°	26.52°	59.78	64.68	52.53
5.	90.6%+9%+0.40%	29.16°	30.84°	24.70°	54.88	62.23	53.90

Table 7: Comparisons of Shear Parameter of 9% RHA Stabilized Reinforced Soil with Plain Soil

Sr. No.	Proportion of Soil, RHA and PP in Percentage (Soil +RHA+PP)	Length of PP					
		10mm	20mm	30mm	10mm	20mm	30mm
		Increase in Angle of Shearing Resistance (Φ)			Increase in Cohesion (c)		
1.	100+0%+0%	20.30°			50.51 kN/m^2		
2..	91%+9%+0%	24.70° (21.67%)			38.71 kN/m^2 (-30.48%)		
3.	90.8%+9%+0.20%	61.08%	48.32%	48.32%	20.29%	13.50%	0.89%
4.	90.7%+9%+0.30%	60.69%	64.24%	30.64%	18.35%	28.05%	3.99%
5.	90.6%+9%+0.40%	43.64%	51.92%	21.67%	8.65%	23.20%	6.71%

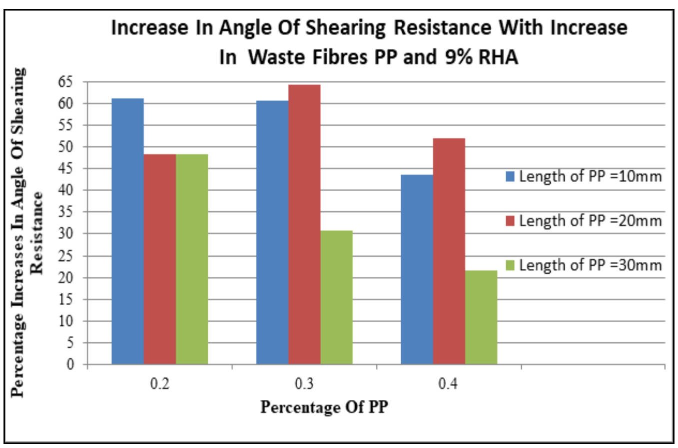

Fig 12: Increase in Angle of Shearing Resistance with the Increase in Waste Fibres PP and 9%RHA

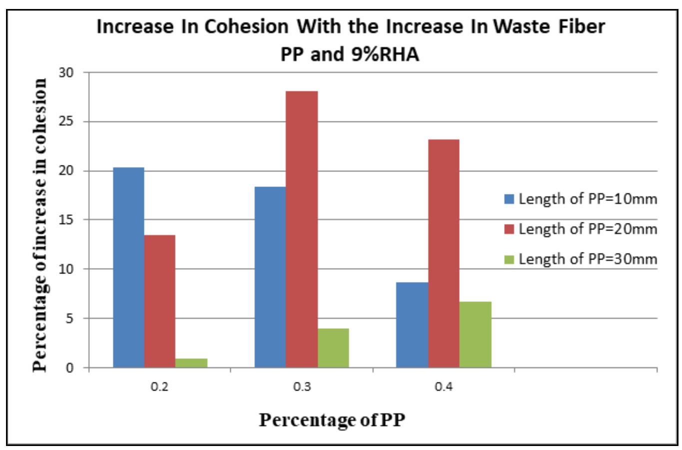

Fig 13: Increase in Cohesion with the Increases in Waste Fibres of PP and 9% RHA

6. Conclusions

The following finding are received from the analysis and interpretations of the results obtained from the experimental investigations

1. It can be concluded that, the MDD goes on decreasing and OMC goes on increasing with addition of polypropylene to the RHA stabilized clayey soil.
2. The optimal dose of RHA was found to be 9%.
3. The clayey soil stabilized with optimum %age (i.e. 9%) of RHA and reinforced with waste fibres of polypropylene of 20mm length and 0.30% weight of polypropylene, the value of angle of shearing resistance (Φ)found to be increased by 64.24% (From 20.30º to 33.34º)and value of cohesion (c)found to be increased by 28.05% (From 50.51 kN/m^2 to 64.68 kN/m^2)
4. The clayey soil stabilized with optimum %age (i.e. 9%) of RHA and reinforced with waste fibres of polypropylene of 20mm length and 0.30% weight of polypropylene, the unconfined compressive strength value found to be increased by 59.34% (From 356.72 $kN/m^2$to 568.40 kN/m^2)
5. The optimal ratio of Soil: RHA: PP for improvement of clayey soil was found to be 90.7:9:0.3 of 20 mm Length
6. Finally it can be concluded that the rice husk ash and polypropylene can be successfully used for enhancement of engineering characteristics of clayey soil.

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