IMPROVEMENT IN STRENGTH OF BLACK COTTON SOIL BY USING RICE HUSK ASH AND EGGSHELL POWDER

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ABSTRACT: The changes made in the soil to enhance its quality as per the requirement is termed as soil stabilization. Properties of soil vary with kind of environment soils are exposed to, so investigation of each soil needs discrepancy from other. In this research, we dealt with the stabilization of highly clayey soil to improve its Physical aspects like its Atterberg's limits, strength parameters and C & ϕ. dealing with highly clayey soil proves a tiresome job for civil engineer. But it its improvisation ought to be cost effective. So, Stabilization is done by using different material which is readily available in locality such as ESP and RHA. We commence our investigation with replacement of RHA and ESP individually in the proportions of beginning from 6%, 12% up to 18% and 2%, 4%, 6% and 8% respectively. Maximum increment in case of ESP is around 353% after 3 days of curing period and around 121% increment is noted in case of RHA. We also add combination of both the material at different proportion to calculate the optimum CBR value after 3 days of curing period. At the proportion of 12% RHA and 6% ESP we got the desired value and CBR increased around 445% in this case. In this research, C and ϕ value is also evaluated at optimum content of ESP, RHA and combination of both the material. It is found that both these values were enhanced.

Keywords: Black Cotton Soil(BCS), Rice Husk Ash(RHA), Eggshell Powder(ESP), Cohession(c), Angle of internal friction(ϕ), Optimum Moisture Content(OMC), Maximum Dry Density(MDD), California bearing Ratio(CBR),

1 Introduction:

BCS is considered as one of the most undesirable soil for any engineering works because of its high swelling property and high permeability and compressibility, it's highly plastic nature makes it very difficult to deal with this soil. BCS stabilize by many methods like lime, mechanical and chemical stabilization etc. There are many stabilizing agents such as ESP, Rice Husk ash, Cement kiln Dust, Ground Nut shell Ash, Quarry dust etc. are used in mechanical as well as chemical stabilization. Various researchers studied on the behavior, chemical and physical properties of RHA and they observed that RHA has pozzolanic properties because high silica content is present in it. RHA cannot be used alone because it has poor cementitious properties. Whereas the chicken eggshell is 97% calcium carbonate elements, which are balanced out by a protein grid. Without the protein, elemental structure would be excessively weak, making it impossible to keep its frame and the natural network is thought to have a part in collection of calcium mineralization procedure. The soil used in this research were collected from Nasik(MP) and ESP and RHA were collected from hostel mess and local rice mill respectively.

Tewar et al. (2014) concluded the effect of egg shell powder on the physical characteristics of the BCS. He found that at optimum content of egg shell powder (at 6%) the free swell index gets reduced and consequently the plasticity of the soil reduced. With the addition of the egg shell powder he found that the OMC of the soil reduces and on other side MDD increases. He also concluded that the UCS and CBR value of the virgin soil gets increased by 80% and 380% respectively. Overall he found that the strength of the soil gets increased with the addition of egg shell powder and Jha et al. (2015) studied the effect of rice husk ash on the soaked and unsoaked CBR value of the clayey soil. The soaked value, unsoaked value and plasticity of the virgin soil were 2.40%, 3.65%

and 26.77%. He found that with the addition of lime and RHA in the soil increases the OMC and reduces the MDD of the soil. Similar experimental works were carried out by various researchers like Anu Paul et al. (2014), Dalal et al. (2017), Yadav et al. (2016), Singh. H (2015), Sharma et al. (2016), Garg. A (2017), Mishra et al (2006), Canacki (2017).

2 Method and Material: The soil used here is black cotton soil which is found in some parts of Rajasthan, Gujarat, Madhya Pradesh, Maharashtra, Andhra Pradesh, and Tamil Nadu. As per Unified soil classification system this soil fall under highly clay (CH) group. The various parameters are shown in table no. 1.

Soil Parameters	**Value**
Liquid Limit	66 %
Plastic Limit	33 %
Plasticity Index	33 %
Sp. Gravity	2.43
In Case of Modified proctor test-: OMC MDD	 13 % 18.2 kN/m^3
In Case of Standard Proctor Test-: OMC MDD	 19 % 13.5 kN/m^3

ESP was collected from the hostel mess and before the grinding eggshells were properly wash with clean water and dried in sunshade for 24-48 hours. After that, Eggshell were grinded properly to obtain uniform and fine powder of size less then 75µ and RHA was collected from local area Rice mill and also sieved through 75µ. The reasoning behind this particle size is that smaller the stabilizer size, lower the void ratio.

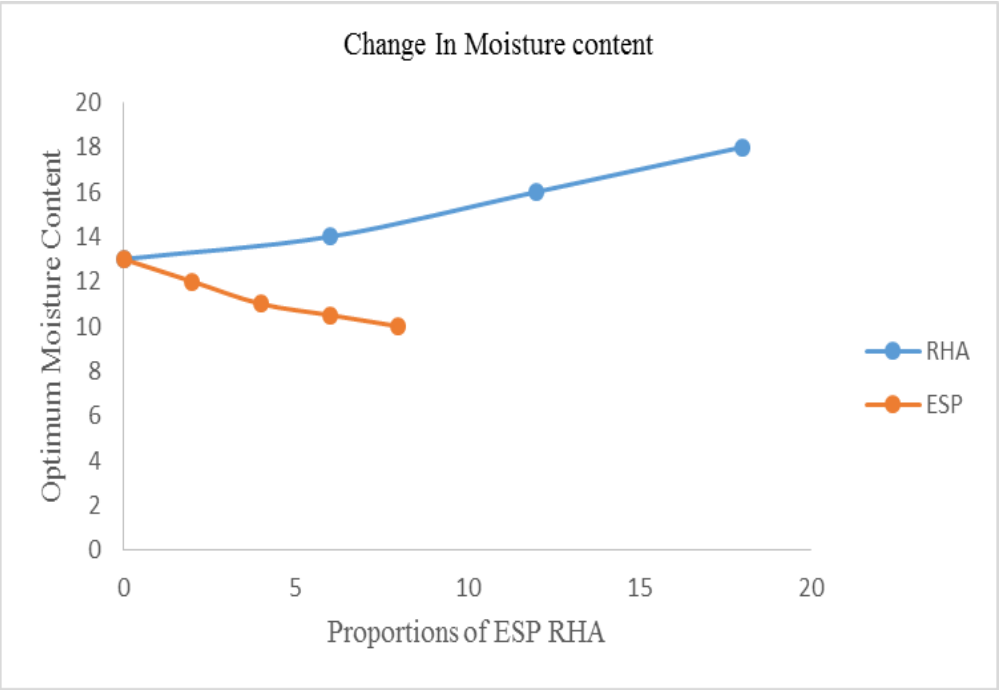
Tests Performed:- Atterberg's Limit, Specific Gravity , Standard Proctor Test (OMC & MDD), Modified Proctor, CBR , Triaxial Test.

3 Result and Discussion

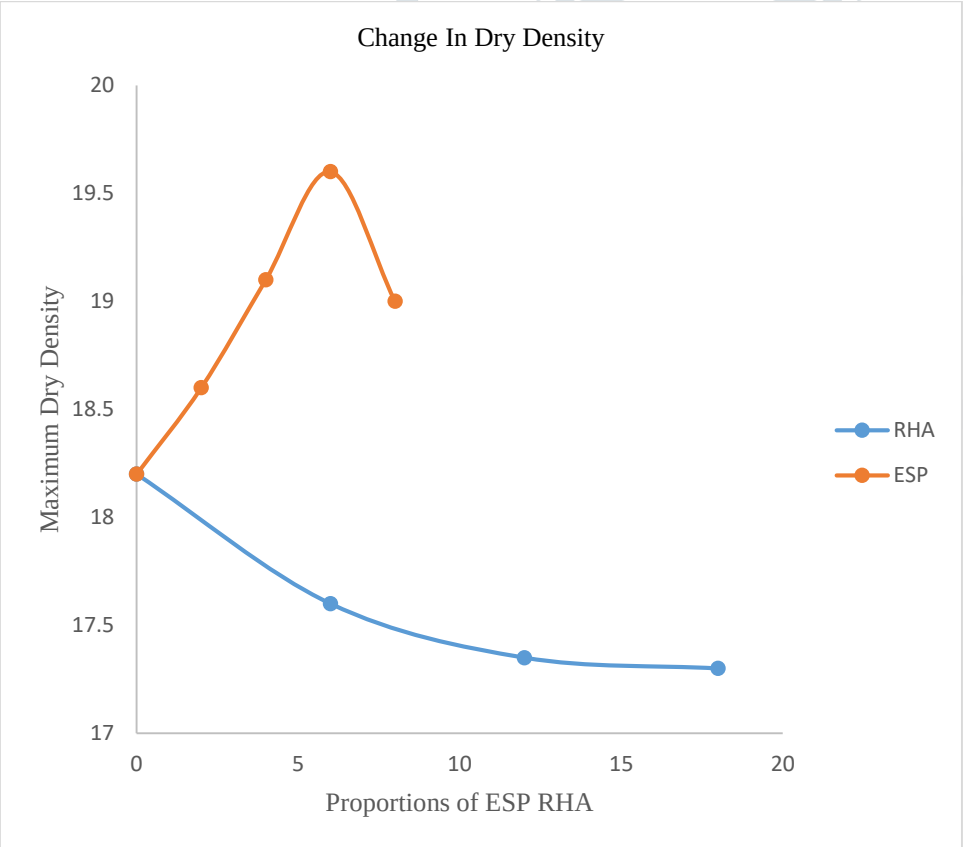
3.1 Observations of tests at different Proportions

Sr. no.	**Soil**	**RHA**	**ESP**	**CBR**	**C**	**ϕ**
1.	**100**	**0**	**0**	**3.2**	**19.6**	**9**

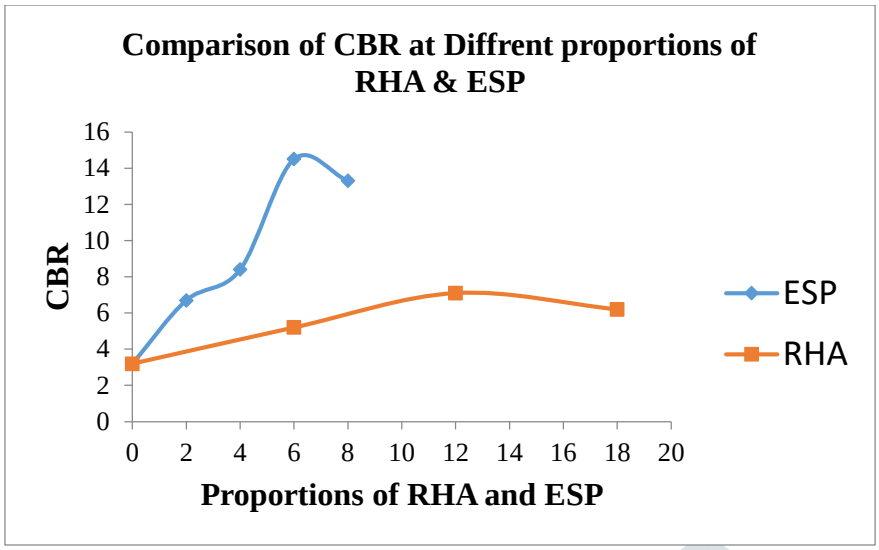
2.	94	6	0	5.2	-	-
3.	**88**	**12**	**0**	**7.1**	**14.7**	**12**
4.	82	18	0	6.2	-	-
5.	98	0	2	6.7	-	-
6.	92	6	2	6.9	-	-
7.	86	12	2	9.2	-	-
8.	80	18	2	8.2	-	-
9.	96	0	4	8.4	-	-
10.	90	6	4	9.3	-	-
11.	84	12	4	11.5	-	-
12.	82	18	4	10.1	-	-
13.	**94**	**0**	**6**	**14.5**	**20.08**	**11**
14.	88	6	6	15.7	-	-
15.	**82**	**12**	**6**	**17.5**	**20.02**	**15**
16.	76	18	6	15.6	-	-
17.	92	0	8	13.3	-	-
18.	86	6	8	14.9	-	-
19.	80	12	8	16.89	-	-
20.	74	18	8	15.3	-	-



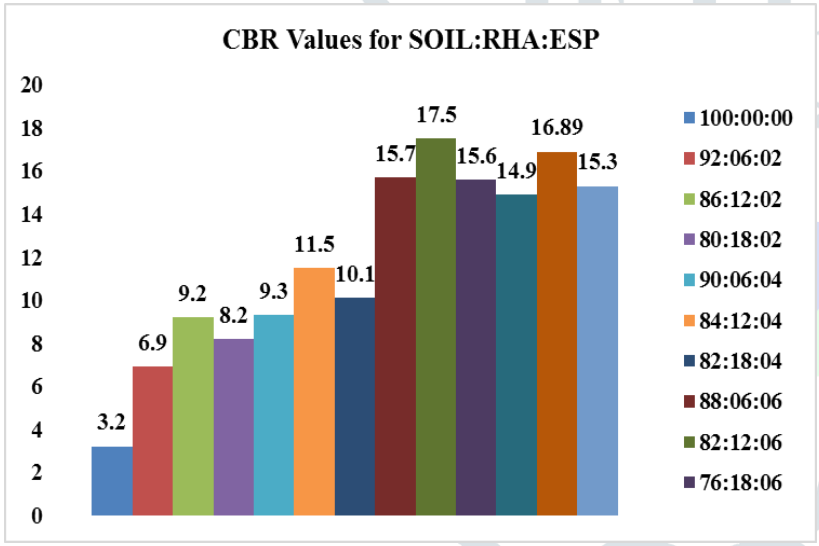
Graph 1



Graph 2



Graph 3



Graph 5

3.2 Discussion

3.2.1 Compaction Features

Compaction results are depicted in Graph 1 and 2 for entire series of specimen prepared in this study. To begin with Virgin BCS has MDD 18.2 kN/m3 corresponding OMC as 13% when performed under Modified Proctor Test. The value of MDD consistently increased from 18.2 kN/m3 to 18.6 kN/m3, 19.1 kN/m3, 19.6 kN/m3 and then decreased to 19kn/m3 for ESP added in 2%,4%,6% and 8% respectively. On the other hand OMC values had drop down from 13 %(for virgin) to 12%, 11%, 10.5% and 19% for above mentioned ESP content.

Opposite effect could be seen on adding of RHA in BCS (at 6%,12%, and 18%). Here MDD decreased from 17.6 kN/m3, 17.35 kN/m3, 17.3kN/m3 for above mentioned RHA content. OMC it valued for 14%, 16% and 18% respectively.

3.2.2 California Bearing Ratio

The CBR tests was performed after 3days of curing period. The CBR value of BCS 3.2% so the additives used to enhance the CBR values show positive results. When RHA and ESP separately used in different proportions 6%,12%,18%and 2%, 4%,6%8, by proportion gave CBR values 5.2%,7.1%,6.2% and 6.7%,8.4%,14.5%,13.3% respectively . We also add combination of both the material at different proportion to calculate the optimum CBR value after 3 days of curing period. At the proportion of 12% RHA and 6% ESP we got the desired value and CBR value at that proportion was 17.5%.

3.2.3 Triaxial test features

The UU-triaxial test have been conducted on the optimum value of each additives. The C, ϕ value of BCS was 196kN/m^{2}and 9^0. Cohesion and angle of internal friction got increase in case of ESP from 196 kN/m^2 to 208 kN/m^2 and 9^o to 10^o respectively, whereas in case of RHA cohesion got decrease from 196 kN/m^2 to 147 kN/m^2 and angle of internal friction tends to increase from 9^o to 12^o. It was also found that the cohesion value increased slightly and angle of internal friction tends to increase from 9^o to 15^o when we add both the additives at their optimum proportions.

4 Conclusion

- It was observed that with increase in the proportion of RHA in BCS, OMC gets increased while MDD tends to reduce, whereas in case of ESP OMC decreased and MDD gets increased.
- When we add both the additives together at different composition in the soil it was concluded that MDD was slightly increased and OMC was reduced slightly.
- It was observed that the CBR value got increase up to 121% in case of RHA after that it start decreasing and in case of ESP it was found that the CBR got increase up to 353%.
- When both additives were introduced in the soil together at different proportion it was found that the CBR value reached the maximum value of 447%.
- It was conclude that the cohesion and angle of internal friction got increase in case of ESP from 196 kN/m^2 to 208 kN/m^2 and 9^o to 10^o respectively, whereas in case of RHA cohesion got decrease from 196 kN/m^2 to 147 kN/m^2 and angle of internal friction tends to increase from 9^o to 12^o. It was also found that the cohesion value increased slightly and angle of internal friction tends to increase from 9^o to 15^o when we add both the additives at their optimum proportions.

5 References

1. Arora, K.R “Soil Mechanics and Foundation Engineering”.
2. Canacki (2016). “*Stabilization of clay using waste beverage cans*”. Geotextiles and Geomembranes, .161: pp. 595-599.
3. Anu Paul (2014). “*Studies on improvement of clayey soil using egg shell powder and quarry dust*”. International.
4. Hassan (2016). “*Remediation of expansive soils using agriculture waste bagasse ash*”. Nebraska Department of Roads- In house Research July 2016.
5. Kuzhali (2017). “*Behavior of expansive soils treated with seashell powder*”. International Journal of Civil Engineering Vol.8 pp. 576-581.
6. Yadu et.al. (2014). “*Comparison of fly ash and rice husk ash stabilized BCS*”. International Journal of Earth Science and Engineering. Vol.4 .pp. 42-45.
7. Mishra (2017). “*Performance of sea shell powder on sub grade soil stabilization*”. International Conference on Research and Innovations in Science, Engineering and Technology. Vol. 1. Pp. 150-156.