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Behaviour of Locally Available Clay modified using Blood Clamshell Powder and Wheat Straw

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Abstract - *Soil is one of the important material for building a modern infrastructure. Now a days, most of failure occurs due to the poor strength. In order to tackle this problem, a wide variety of additives like Lime, sodium carbonate, sodium sulphate, etc. can be used but these are very expensive while looking through economic point of view. Therefore, it's preferable to replace these by another kind of soil additive to make them economical and eco-friendly. Most of the area, which is undergoing rapid industrialization, consists of extremely soft clay calling for expensive deep foundations. In our study we will do an experimental study on stabilization of locally available clay using Blood Clamshell powder (BCP) and wheat straw (WS) in varying proportions. Three various proportions of BCP (0%, 2.5%, 5%, 7.5%, 10%) & wheat straw (0%, 0.5%, 1.0%, 1.5%, 2.0%) were added to obtain optimum percentage of each additive. The analysis was done by standard proctor compaction test and unconfined compression strength test. The BCP and WS contents will have significant effect in engineering properties of soil. After the stabilization of the clay, both the results were compared to arrive at the optimum percentage of additives required for the clay to become strong foundation for construction.*

Key Words: Locally available clay, Blood clamshell powder, wheat straw, Standard Proctor compaction test, unconfined compressive strength test, optimum percentage.

1. INTRODUCTION

Soil stabilization refers to the process of improving various aspects of the soil by adding certain additives, special soil or cement properties to it. It is the biological, chemical or mechanical modification of earth engineering structures. In civil engineering, soil stabilization is a method used to refine and improve land engineering strength. These include mechanical strength, physical strength, durability, compressibility, permeability and plasticity. In any construction project, whether it's a building, a road, or an airport, the ground floor serves as a foundation. But today, most failures occur due to low load capacity. Unstable soils can cause many important structural problems related to overcrowding, slope instability, capacity to carry heavy loads, etc. To address this problem, various additives such as Lime, sodium carbonate, sodium sulphate, etc. can be used, but these are very expensive when you look at the economic perspective. Therefore, it is best to replace this with another type of soil supplement to make it more economical and eco-friendly. Most of the area, with rapid industrial development, consists of soft clay that costs expensive deep foundations. The use of local property to support infrastructure needs, had to be assessed to show that local property has the potential to be used as a building material and building. Blood Clamshell Powder contain significant amount of lime / calcium oxide (CaO) content, indicating that it is the main ingredient in the reaction of cement when exposed to water. Since Clamshell powder is a waste product, stabilizing using this proves to be an eco-friendly method. In addition, Clamshell powder can be incorporated into a subsoil layer to improve not only strength but also soil stability. Using clamshell as stabilizing materials will reduce the ecological and environmental impact of soil conservation work.

Very recently, attempts have been made by various researchers to use the natural waste fibers (human hairs) as reinforcing material with different types of soils such as clay and sand. These studies concluded that the human hair fibers are effective in increasing the strength characteristics of soils and the optimum fiber content lies between 0.5 to 2%. This study deals with the usage of the wheat straw fibers as a reinforcing material with the soil to investigate the effect of reinforcement on geotechnical properties of soil. Various studies focused to use wheat straw fibers in developing composite materials, but the studies on use of wheat straw fibers as reinforcement with soils are very limited, and no research paper is found available online. Thus, there is an ample scope to explore the use of wheat straw fibers for soil reinforcement. In the present study, an attempt has been made to evaluate the engineering properties of locally available clay reinforced with wheat straw fibers. For this study, a set of laboratory tests was performed on the reinforced soil as well as on virgin soil to compare the effectiveness of wheat straw reinforcement.

2. MATERIALS USED

2.1 Soil

A sample of the clayey soil (Figure 1) is collected from a site in Aruvikkara Panchayat at a depth of about 4 meters from

the ground. The collected sample was light in colour and rich in moisture content. It is allowed to sun dry for a period of 4-5 days to determine its various index, geotechnical and engineering properties as per standard specifications. According to ASTM standards, the collected soil sample is categorized as high plastic clay, which is represented as CH.

Fig -1: Locally available clay

The various properties of soil sample is given in table 1 below.

Table -1: Properties of locally available clay

Soil properties	Values
Natural water content	49.624%
Specific gravity	2.61
Unconfined Compressive Strength	6.34 kg/cm^2
Shear Strength	3.17 kg/cm^2
Liquid limit	147.5%
Plastic limit	105.68%
Toughness index	2.48
Liquidity index	0.073
pH	6.73
Free swell index	1.96%
% clay	53.5%
% silt	29.5%
% fine sand	17%
Maximum dry density	1.6 g/cc
Optimum moisture content	25%

2.2 Blood Clamshell Powder (BCP)

Blood Clamshell in powdered form is purchased from a local store in Trivandrum and the sample that passed through 75µm sieve were collected for the experiment for better efficiency.

Fig -2: Blood Clamshell Powder

2.3 Wheat Straw (WS)

The wheat straw fibers used in this study were obtained from a local farmer in Aruvikkara panchayat. The moisture content of fiber was found to be around 4- 5% using oven drying method. The length of WS varied from 10 to 50 mm. Wheat straws were washed with water to remove the unwanted dirty sticky impurities, followed by drying in an oven at 72°C for 48 h to remove moisture. The length of fiber specimens was kept within the range of 10-50mm.

Fig -3: Wheat Straw

3. EXPERIMENTAL METHODS

In our project we started our study by collecting the sample from a site in Aruvikkara Panchayat. The sample was dried in open sunlight and preliminary test on raw sample was conducted. The various test conducted on the sample were specific gravity, sieve analysis, hydrometer, atterberg's limit, standard proctor and Unconfined compressive strength (UCC). The clay sample were prepared with a varying proportion of seashell powder and straw fiber as 0%, 2.5%, 5%, 7.5% and 10%(BCP) and 0%, 0.5%, 1%, 1.5%, and 2% (WS). Standard proctor and UCC were conducted on prepared specimens and obtained the optimum percentage of stabilizing agents required. In our study we mainly focused on compaction and unconfined compression test.

3.1 Compaction test

Compaction is the process of soil compaction by reducing air spaces. The degree of soil compaction provided is measured in terms of dry matter The dry density is maximum at the optimum water content. A curve is drawn between the water content and the dry density to obtain the maximum dry density and the optimum water content.

Dry density = (M / V) / (1+ w)

3.2 Unconfined Compression test

The unconfined compressive strength is the load acting per unit area at which the cylindrical specimen of a cohesive soil fails in compression.

$q_u = P / A$,

where, P - axial load at failure,

A - Corrected area = $A_o / (1- \varepsilon)$,

A_o- initial area of the specimen,

ε- Axial strain= change in length/original length

4. RESULT AND DISCUSSION

After collecting the stabilizing agents and clay sample, its physical properties were analyzed. Thereafter the clay was stabilized with stabilizing agents and various tests were conducted to determine its geotechnical properties. The test conducted on stabilized sample are UCC and standard proctor. The test was done twice to get accurate result and the average of the values were taken. These results are given in the tables below with corresponding graphs.

4.1 Unconfined compressive strength test

4.1.1 Blood clamshell powder (BCP)

After the detailed analysis on the unconfined compressive strength of collected locally available clay has been done, the following results have been achieved. UCS test as per IS 2720 part 10 -1991 were performed using different proportions of clamshell powder and results are shown in table 2.

Table -2: UCC test results for BCP

Blood Clamshell powder (%)	UCC values (kg/cm^2)
0	6.34
2.5	7.54
5	9.41
7.5	9.25
10	6.56

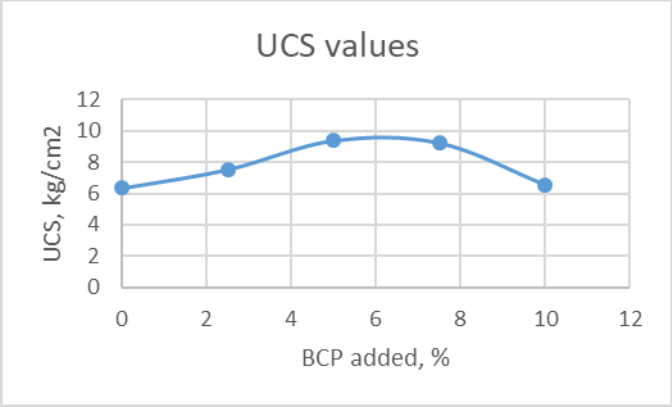

Chart -1: Graph showing variation of strength with clamshell powder

From the above graph we can clearly state that unconfined compression strength values are increasing up to 5% BCP content and thereafter showing a declining trend. At this stage the clamshell powder absorbs more moisture and acquires a better bond between the powdered clamshells and the particles of the clayey soil.

4.1.2 Wheat straw (WS)

Unconfined compressive strength (UCS) test was conducted on unreinforced and fiber reinforced specimens with different fiber contents. The results show that the fiber inclusion significantly increases the compressive strength of fiber-reinforced soil as compared to unreinforced soil. However, the maximum increase in the UCS value is observed for the 1.5% of fiber inclusion to the soil, thereafter UCS value decreased with further increase in fiber content inclusion. The variation of UCS values with fiber content is shown in Table 3 and chart 2, which indicates that there is a significant improvement in compressive strength of soil with wheat straw fiber reinforcement. It can be explained that the increase in UCS value or the shear strength of soil with low percent of fiber content, ie, up to 1.5% can be attributed to the fact that the fibers randomly aligned in the soil and close the shear plane would experience tension and thereby the failure strength of soil reinforced with straw fibers. However, with an increase in the fiber content beyond 1.5%, the fibers by volume become larger. Therefore, while the specimen is being loaded or sheared, the tensile effect of fibers is not triggered. Also, with more volume of fibers, there may be higher possibility of fibers getting aligned along the shear plane while shearing and thereby the strength at failure reduces.

Table -3: UCC test results for WS

Wheat straw (%)	UCC values (kg/cm²)
0	6.34
0.5	7.52
1	7.60
1.5	7.77
2	7.29

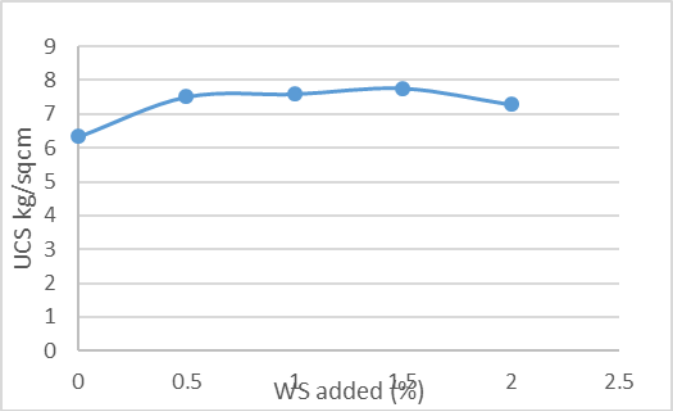

Chart -2: Graph showing variation of strength with wheat straw content

4.2 Standard proctor compaction test

4.2.1 Blood clamshell powder

In this test to determine the density of dry density (MDD) and Optimum moisture content (OMC) with different percentages of BCP, different results were obtained as given in the table 4.

Table 4: Summary of MDD and OMC values for different percentages of BCP

Percentage of BCP in soil sample (%)	Maximum dry density (g/cc)	OMC (%)
0	1.60	25.00
2.5	1.62	24.80
5	1.82	23.70
7.5	1.80	23.36
10	1.77	26.03

From the above data, it can be seen that in every increase the percentage of clamshell powder results in an increase in the amount of maximum dry density. The highest incidence of MDD was found in 5%. In the case of OMC, it can be found that the water content continues to decrease as the percentage of seashell grows. Also, it should be noted beyond a decreasing trend of values, the optimum moisture content increases. This means that the reaction takes place between water and the compounds present in the mixed sample.

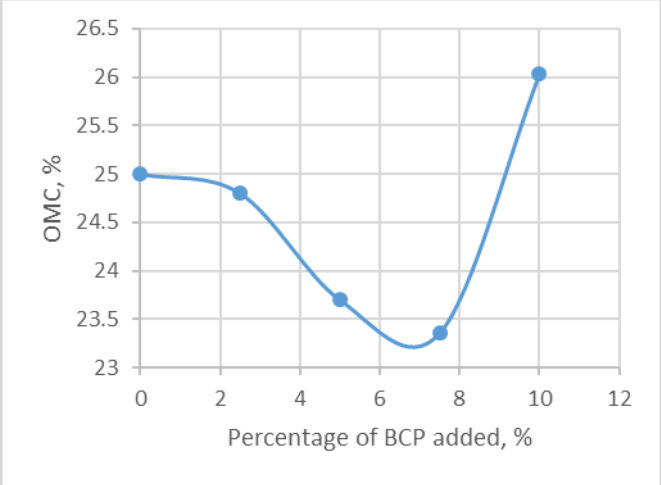

Chart -3: Variation of OMC with clamshell powder content

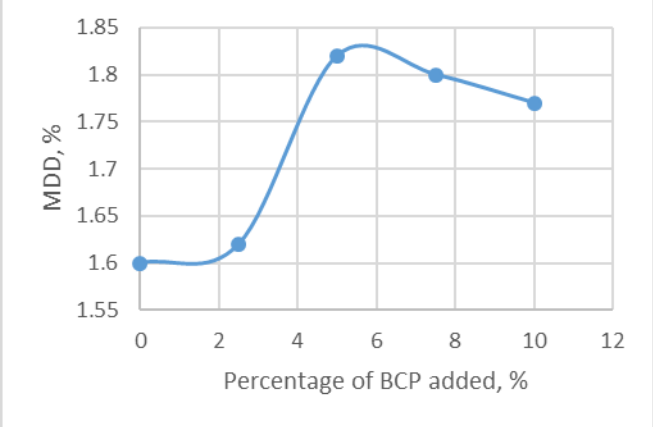

Chart -4: Variation of MDD with clamshell powder content

4.2.2 Wheat straw

The variation of MDD and OMC with fiber content is shown in table 5. It is noticed from chart 5 and chart 6 that the values of OMC increase while that of MDD decreases with increasing fiber content. Nevertheless, the reduction in MDD is marginal only. Marginal reduction in the MDD of the matrix is due to the light weight nature of wheat straw fibers mixed with the soil which reduces the dry density. But, it is evident that reinforcement primarily affects the maximum dry density and also has an effect on the optimum water content.

Table 5: Summary of MDD and OMC values for different percentages of WS

Percentage of WS in soil sample (%)	Maximum dry density (g/cc)	OMC (%)
0	1.60	25.00
0.5	1.54	25.60
1	1.45	30.70
1.5	1.48	25.80
2	1.42	25.50

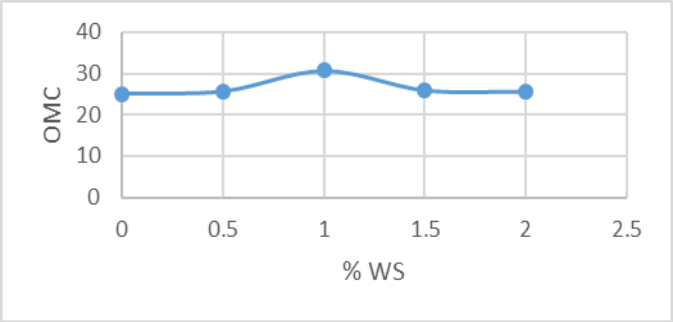

Chart -5: Variation of OMC with varying percentages of fiber inlusion

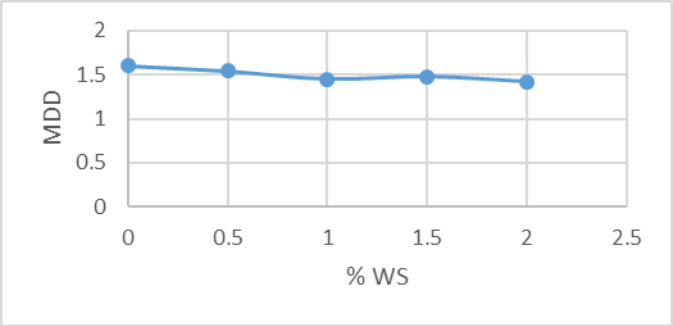

Chart -6: Variation of MDD with varying percentages of fiber inclusion

3. CONCLUSIONS

Based on the results, the following conclusions may be reached:

1) The optimum moisture content showed a decreasing pattern on increasing BCP content and afterwards OMC value showed an increasing trend. An increase in optimum moisture content with an increase of in fiber content is noticed, but the increase is insignificant.

1) There is an increase in the maximum dry volume weight for each percentage increase of Clamshell powder. The MDD value reached to a maximum value and thereafter it decreased. However, the maximum dry density of the soil-fiber matrix is found to decrease marginally with an increase in the fiber content.

2) From the results of the UCC test, there is an increase in the unconfined compressive strength of the clayey sample collected with increase in shell powder. The value showed an increasing trend initially and subsequently the value followed a declining trend. In case of WS, the above mentioned variation trend is observed with increasing percentage of fiber content.

3) The use of clamshell powder and wheat straw fiber to stabilize the clay to meet the basic stabilization requirements has proven and it can be concluded that the optimum percentage can be taken as 5% of the dry soil weight for BCP and 1.5% of dry weight of soil for WS, which is similar to the optimum fiber content of other types of natural and synthetic fibers.

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REFERENCES

[1] Masyitah Md Nujid, Juliana Idrus, Duratul Ain Tholibon, Nor Faizah Bawadi, Ali Akbar Firooz, Bearing Capacity of Soft Marine Soil Stabilization with Cockel Shell Powder(CSP), International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 - 8958,Volume -9, Issue 3, February, 2020.

[2] Mittal, V., and S. Sinha. 2017. Study the effect of fiber loading and alkali treatment on the mechanical and water absorption properties of wheat straw fiber-reinforced epoxy composites. Science and Engineering of Composite Materials 24 (5):731–38. doi:10.1515/secm-2015-0441.

[3] Babu T. Jose, A. Sridharan, and B. M. Abraham (1988) A Study of Geotechnical Properties of Cochin Marine Clays. Marine Geotechnology 7(3):189-209, DOI: 10.1080/10641198809388216

[4] Aminaton Marto, Nor Zurairahetty Mohd Yunus, Faizal Pakir, Nima latifil, Ahmad Hakimi Mat Nor and Choy Soon Tan (2015) Stabilization of Marine Clay by Biomass Silica (non-traditional) Stabilizers. Applied Mechanics and Materials Vol. 695 (2015) pp 93-97.

[5] K. Mounika, B. Satya Narayana, D. Manohar, K. Sri Harsha Vardhan (2014) Influence of sea shells powder on black cotton soil during stabilization. International Journal of Advances in Engineering & Technology, 7(5), pp. 1476-1482

[6] Pebri Putra Hidayat (2021). Subgrade Stabilization With Powder Clamshells As An Alternative Lime Substitute. American Journal of Engineering Research 10 (01), pp-179-188

[7] Rudhy Akhwady, Ridho Bayuaji (2017) The Influence of Clamshell on Mechanical Properties of NonStructure Concrete as Artificial Reef. Asian Journal of Applied Sciences 5(8), pp 389-395.

[8] Aminaton Marto, Nor Zurairahetty Mohd Yunus, Faizal Pakir, Nima latifil, Ahmad Hakimi Mat Nor and Choy Soon Tan (2015) Stabilization of Marine Clay by Biomass Silica (non-traditional) Stabilizers. Applied Mechanics and Materials Vol. 695 (2015) pp 93-97.

[9] Bouhicha, M., F. Aouissi, and S. Kenai. 2005. Performance of composite soil reinforced with barley straw. Cement and Concrete Composites 27 (5):617–21. doi:10.1016/j.cemconcomp.2004.09.013.

[10] Min Lia,n , Shou Xi Chaib , Hu Yuan Zhanga , Hong Pu Duc , Li Wei. 2012. Feasibility of saline soil reinforced with treated wheat straw and lime. Soils and Foundations 52(2):228–238.

[11] Sunil Kumar Meena, Raghvendra Sahu & Ramanathan Ayothiraman (2019): Utilization of Waste Wheat Straw Fibers for Improving the Strength Characteristics of Clay, Journal of Natural Fibers, DOI: 10.1080/15440478.2019.1691116.

[12] Suthar, M., & Aggarwal, P. Bearing ratio and leachate analysis of pond ash stabilized with lime and lime sludge. Journal of Rock Mechanics and Geotechnical Engineering,2018;10(4):769–777. https://doi.org/10.1016/j.jrmge.2017.12.008

[13] Mokhtar, M., Hamid, N. B., Aimi, S., Mohd, N., & Sani, S. An experimental study on dust shell as an admixture in soft soil stabilization. In ARPN Journal of Engineering and Applied Sciences, 2016;11(11):7254-7257.

[14] Ruiz, G., & Farfan, P. Use of crushed seashell by-products for sandy subgrade stabilization for pavement purpose. In 14th LACCEI International Multi-Conference for Engineering, and Technology,2016:1-6.