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STABILIZATION OF LOCALLY AVAILABLE CLAY WITH BLOOD CLAMSHELL POWDER AS A SUBSTITUTE FOR LIME

[1]Reshma P S, [2]Melissa Marian Ninan

[1]M Tech Student, [2]Assistant Professor

[1]Department of Civil Engineering

[1]St. Thomas Institute for Science and Technology, Trivandrum, Kerala, India

Abstract : Stabilization in soft soils in India often use lime to reduce soil plasticity, increase strength and endurance, reduce water absorption and inflammation caused by water. Lime is found not only in limestone mines (limestone) but also in clam shells. This study will therefore use Blood Clamshell powder (Tegillarca Granosa) instead of lime to stabilize the soil. A soil sample is collected at the Aruvikkara Panchayath site to a depth of about 4m and all its index properties, geotechnical and engineering properties were determined. The various tests performed on the sample were to determine the natural water content, specific gravity, sieve analysis, hydrometer, atterberg limit, standard proctor, pH test, freeswell index test, unconfined compressive strength test (ucc). Five different BCP values (0%, 2.5%, 5%, 7.5%, 10%) were added to obtain the best percentage. The analysis was performed with a standard proctor compaction test and unconfined compressive strength test. Various studies on experimental basis have revealed that BCP has a noteworthy effect on global engineering properties and the results were analyzed to achieve the high percentage of ingredients needed to form a solid foundation.

***Index Terms* – Locally available clay, Blood Clamshell Powder, lime, Optimum percentage, Standard Proctor, Unconfined Compressive Strength.**

I. INTRODUCTION

Soil stabilization refers to the process of improving various aspects of the soil by adding certain additives, special soil or cement structures 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 the capacity of earth engineering structures. These include mechanical strength, physical strength, durability and plasticity. In any building project, whether it be a building, a road, or an airport, the ground floor serves as a foundation. Nowadays, most of the prominent structural collapses are due to inadequate soil strength. Unstable soils can cause many important structural problems related to overcrowding, slope instability, heavy load capacity, etc. To solve this problem, various additives such as Lime, sodium carbonate, sodium sulphate, etc. it is expensive when you look at the economic perspective. Therefore, it is better to replace this with another type of soil supplement to be more economical and eco-friendly than regular lime. Most of the area, with rapid industrial development, consists of soft clay that calls for expensive deep foundations. The use of local property to support infrastructure needs, had to be assessed to determine whether local property has the potential to be used as a building and building material.

Blood Clamshell Powder contains a significant amount of lime / calcium oxide (CaO) content, indicating that it is a key ingredient in the reaction of cement when exposed to water. Since Clamshell powder is a waste product, stabilizing using this proof is an eco-friendly method. In addition, Clamshell powder can be added to a subsoil component to improve not only strength but also soil stability. Using clamshell as stabilizing materials will reduce the environmental impact of the conservation work.

This paper describes the results based on local soil-based stabilization studies using Blood Clamshell powder (BCP) in various doses.

II. MATERIALS USED

2.1 Soil

A sample of clay soil (Figure 1) is collected at the Aruvikkara Panchayat site at a depth of 4 m from the ground. The collected sample was light in color and rich in moisture content. Drying in the sun for 4-5 days is allowed and its various indexes, geotechnical and engineering properties were determined as per standard specifications. The collected soil sample is a type of CH, that is, high plasticity as per ASTM standards.

Fig 1: Locally available clay

The various properties of the soil sample are given in table1.

Table 1: Soil properties of collected sample

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
Cohesion, c	3.17kg/cm^2
Angle of internal friction	45 degrees
Liquid limit	147.5%
Flow index	42.59%
Plastic limit	105.68%
Activity	1.97%
Toughness index	2.48
Liquidity index	0.073
Relative consistency	0.926
pH	6.73
Free swell index	1.96%
% clay	53.5%
% silt	29.5%
% fine sand	17%
Uniformity coefficient	3.42
Coefficient of curvature	0.59
Maximum dry density	1.6g/cc
Optimum moisture content	25%

2.2 Blood Clamshell Powder :

A well-processed blood clamshell powder purchased at a store in Trivandrum and it is ensured that the seashell powder has passed through 75µm filter for better performance (Figure 2).

Fig 2: Blood Clamshell Powder

The chemical elements contained in BCP can be seen in Table 2 as follows.

Table 2: Chemical elements of BCP (Source: Pebri Putra Hidayat, 2021)

Component	Content (%)
Silica / Silicon dioxide (SiO_2)	4.9
Sulfur (SiO_3)	0.37
Calcium Oxide (CaO)	87.47
Titanium/ Titania (TiO_2)	0.1
Chromium (Cr_2O_3)	0.13
Manganese Oxide (MgO)	0.63
Iron (Fe_2O_3)	5.13
Copper (CuO)	0.036
Strontium (SrO)	0.57
Europium (Eu_2O_3)	0.2
Ytterbium (Yb_2O_3)	0.44

III. RESEARCH METHODOLOGY

For this project, a sample is collected from Aruvikkara panchayat. The sample was dried in the open sun for 4-5 days and all basic laboratory tests were performed to obtain all of its engineering features. Various tests performed to determine natural water content, specific gravity, sieve analysis, hydrometer, atterberg limit, standard proctor, pH test, free swell index test, unconfined compressive strength test (UCC). Clay samples were prepared with a combination of different BCP measurements such as 0%, 2.5%, 5%, 7.5% & 10% of dry soil weight. The Standard Proctor Compaction and UCC tests were performed on the modified sample for carrying out the study.

3.1 Unconfined Compression test (IS:2720 (PART 10)-1973)

Unconfined compressive strength (qu) is defined as the load applied to each unit area of an unconfined template of the clayey soil cylinder that fails under compressive pressure. UCS testing is the most popular way to determine the shear strength of the soil because it is one of the fastest and cheapest ways. The method is mainly used for saturated as well as for cohesive soils recovered from thin-walled sampling tubes.

$q_u = P / A$

where P - axial load fails

A – corrected area = $A_o / (1- \varepsilon)$

A_o- initial area of specimen

ε- Axial strain = change in length / original length.

3.2 Compaction test (IS-2720-PART-7-1980)

Soil compaction tests were performed using the Proctor test to understand the characteristics of soil compaction and moisture changes. Optimum moisture is the perfect moisture content when the soil becomes very dense and reaches its dry density by removing air gaps. A graph is drawn between the water content and the dry matter to determine the maximum dry matter and the water content and the resulting curve is called the compaction curve.

$$\text{Dry density} = (M/V) / (1+w)$$

where, M = total mass of the soil

V = volume of soil

w = water content.

IV. RESULT AND DISCUSSION

After collecting the stabilizing agents and the clay sample, its physical properties were analyzed. The clay was then modified by reinforcing agents and various tests were performed to determine its geotechnical properties. The tests done on stabilized sample were UCC and Standard Proctor Compaction testing. The test was performed twice to obtain an accurate result and a quantitative measure was taken. These results are presented in the tables below with the corresponding graphs.

With different percentages of sea shell powder added to soil mass, the UCS test according to IS 2720 part 10 -1991 was performed and the results are presented in the form of tables and figures.

Fig 3: Unconfined Compressive Strength Test Apparatus

Table 3 : UCS values

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

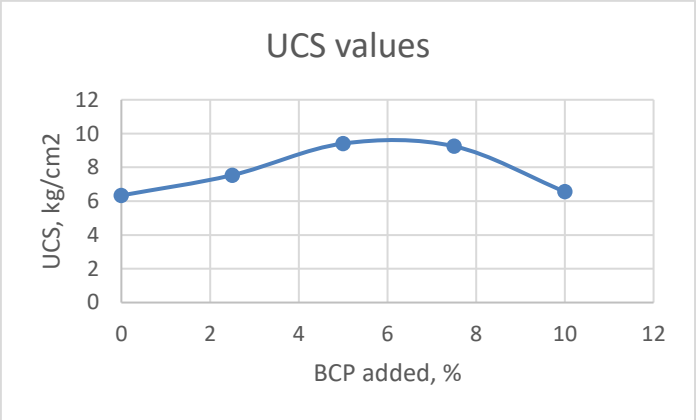

Fig 4 : Variation of UCS with percentage of BCP

From the graph above we can clearly say that the values of the unconfined compressive strength increase up to 5% of the BCP content and thereafter show a declining trend. At this stage clamshell powder absorbs more moisture and acquires a better bond between the powdered shells and the clay particles.

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

Table 4: Compaction test results

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 dry density. The highest value of MDD was found in 5%. In the case of OMC, it can be found that the water content continues to decline as the percentage of marine shell grows. Also, it should be noted that despite the declining price trend, high humidity increases. This means that the reaction takes place between water and compounds present in a mixed sample.

While using a cement-dust-shell (DS) shell to stabilize soft soils, the addition of additives slightly increases dry matter and reduces high humidity [12,13]. Increased drying occurs because particles that are agglomerated and flocculated in the soil take up large gaps and the reason for the decrease in OMC is that, cement requires more water to react pozzolanic. Similar effects can be seen when

crushed marine shell is added to sandy soils for solidification [14]. The composite soil mixture acts as a bond between particles such as the soil matrix and the crushed shell as a dispersed phase with minimal surface contact (particle size and size) creating more gaps thus reducing soil compaction [1].

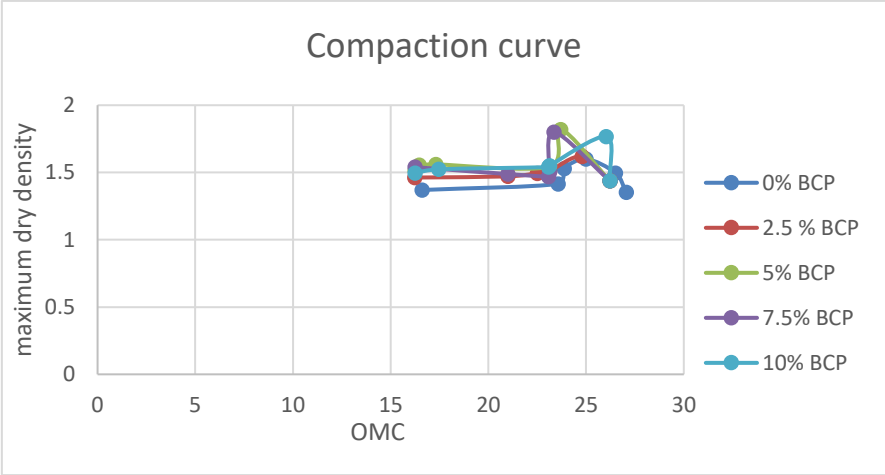

Fig 5: Compaction curve

The graph above shows the relationship between MDD and OMC in the different percentages of clamshell powder.

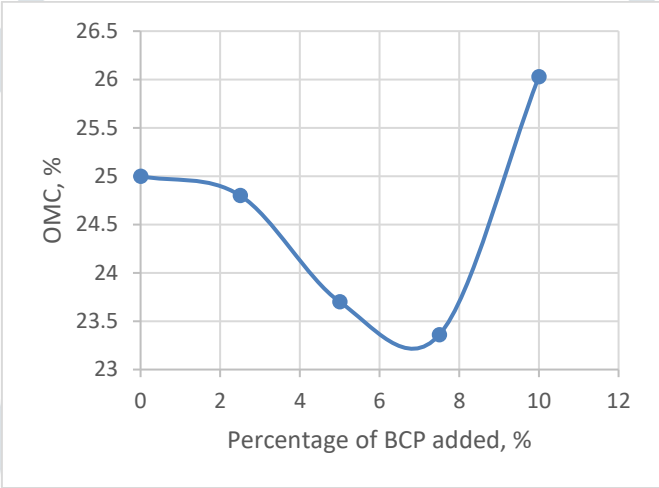

Fig 6: Relationship between OMC with mixed variations

Figure 6 shows that with an increase in BCP percentage the OMC shows a declining trend of 7.5% and above that the OMC is showing an increase in value.

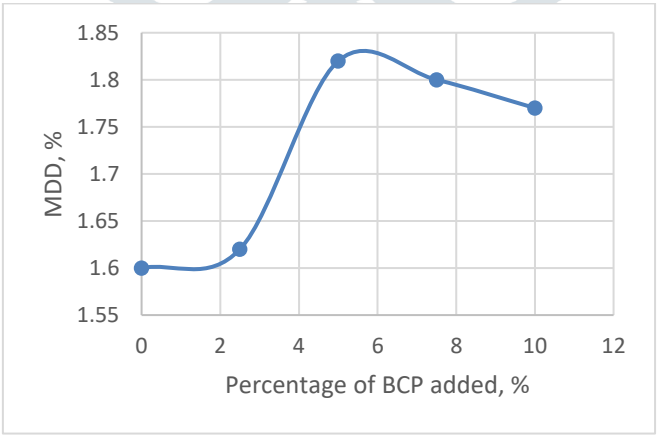

Fig 7: Relationship between MDD with mixed variations.

Figure 7 shows the relationship between MDD and different percentages of BCP in a sample of clay found locally. The graph above shows that the MDD sample rises to 1.82 g / cc of BCP content of 5% of dry soil weight and subsequently shows a declining trend.

V. CONCLUSION

In the present study, various geotechnical properties of locally available clay under the influence of Blood Clamshell powder as an alternative to lime for stabilization were investigated. Clayey soils were reinforced with BCP content from 0, 2.5, 5, 7.5, and 10%. The Index testing, compaction testing and Unconfined Compressive Strength testing were performed to determine stable clay soils with BCP. Based on the results, the following conclusions may be reached:

1) From the results of the compaction test, 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 of 1.82 g/cm^3 for a 5% mixed sample and thereafter it decreased. Although the optimum moisture content showed a decreasing pattern upto a value of 23.36% for 7.5% and afterwards OMC value showed an increasing trend.
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 increased from 6.34 kg/cm^2 for 0% BCP to 9.41 kg/cm^2 for 5% BCP and subsequently it decreased.
3) The use of clamshell powder 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.

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