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STABILIZATION STUDIES THROUGH IMPROVED STRENGTH CHARACTERISTICS OF KAOLINITE CLAY USING GROUNDNUT SHELL ASH AND ONION PEEL POWDER

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Abstract: Industrialization and urbanization have polluted available land, and most agricultural land has recently been converted to development sites. When exposed to changes in water concentrations, a large section of agricultural land has expansive soil with significant inflammation and shrinkage properties. Valorization of waste from groundnut mills and onion peel waste in improving soil properties used for building and construction projects are cost-effective and economically feasible waste management methods. As a result, the purpose of this research is to examine the qualities of clayey soils containing varied percentages of G.S.A. and O.P.P. The atterberg limits-plastic limit, liquid limit, plasticity index, California bearing ratio, shear strength, and moisture content tests were used to evaluate the efficacy of G.S.A. and O.P.P. in improving soil parameters. Improved soil efficiency and geotechnical qualities have also been emphasized for long-term use in various commercial activities. With the addition of 2%, 4%, 6%, 8% of G.S.A and 10%, 20%, 30%, 40% of O.P.P., Unconfined Compressive Strength (UCS), Plastic Limit, Compaction, Liquid Limit, and California Bearing Ratio (CBR), significantly increase till certain limit.

IndexTerms **- Stabilization, Kaolinite Clay, G.S.A., O.P.P.**

I.INTRODUCTION

Kaolin deposits can be found in India's northeastern area. Deopani, in Assam's Karbi Anglong District, has a kaolinite deposit of roughly 1.0 million tones. The clay is still being extracted. It is linked to various black-colored, iron-bearing components, lowering the clay's value. A detailed inspection of the characterization and beneficiation of clay for various uses is required for its utilization. This research looks into the characteristics of the deposit's clay, as well as the feasibility of beneficiating it for diverse purposes utilizing well-known methods like size separation, magnetic separation, and organic acid leaching. Kaolinite clay is a highly adaptable industrial material. Clay was used as a ceramic base material for the first time. Currently, the clay is used as a paper coating and filler pigment, as well as filler in paint, rubber, insecticide, pharmaceutical formulations, and cosmetics.

II. OBJECTIVES

i. To find out about the geotechnical properties of Kaolinite soil.
ii. To determine the change in geotechnical properties, upon addition of different percentage of G.S.A. and O.P.P.
iii. To demonstrate the effect of G.S.A. and O.P.P. on soil compaction characteristics and strength.
iv. To determine the usefulness of G.S.A. and O.P.P. as soil reinforcement.
v. To arrive at the optimum dosage of G.S.A. and O.P.P.
vi. To evaluate the suitable blend that can be used in stabilization of Kaolinite soil.
vii. Utilize locally available materials to reduce construction costs.

III. SCOPE

In order to achieve the above objectives, the following properties are investigated starting with 0% - 40% onion peel powder and 0% - 8% groundnut shell ash mixed with the soil. The following basic geotechnical properties were considered for the study.

a) Plasticity characteristics
   i. Liquid limit
   ii. Plastic limit
   iii. Plasticity index
b) Compaction characteristics
c) Strength characteristics
   i. CBR test
   ii. UCS test

IV. LITERATURE REVIEW

- S. karthikeyan and B. Selvarani investigated that Onion ash and powder have a greater specific gravity. The liquid limitation was reduced slightly using onion powder. The plastic limit was reduced in both onion ash and onion powder. The strength of UCC and Direct shear both increased significantly, although onion ash increased very slightly. When compared to onion powder, onion ash has a higher carrying capacity. Onion ash has a better shear strength and resistance than onion powder. Onion ash, unlike onion powder, can withstand liquefaction, collapse, and structural subsidence. (B.Selvarani, 2021[4])
- Navanmi Chandra B and Veena Vijayan L investigated that the addition of Bamboo fiber, Banana fiber and RHA, improved the clayey soil's characteristics. The optimum moisture content and maximum dry density increase when Bamboo fiber, Banana fiber and RHA are added. However, when the right amount of RHA is mixed in with the various percentages of Banana fiber and Bamboo fiber the optimum moisture content rises while the maximum dry density falls. The optimal percentage of RHA has been determined based on the test findings. By adding the optimal percentage of RHA to the various percentages of Banana fiber and Bamboo fiber in the soil, the ideal proportion is 1% and 0.5%. (B, 2017[3])
- P.Ranga Ramesh, Dr D shrinivas and V.Subhasini investigated that the plastic limit has been increased because groundnut shell ash was added to black cotton. This change in soil character is most likely due to the GSA providing bivalent calcium ions, which replaced less securely bound monovalent ions in the double layer enclosing the clay particles, increasing the plastic limit. The plastic limit increased with a higher dose of GSA, owing to an increase in the amount of particles in the mixture. Since the plasticity index is calculated using the plastic and liquid limits, no independent approach for lowering the plasticity index, which represents soil workability, has been proposed. With the addition of groundnut shell ash to the black cotton soil, the shrinkage limit continues to rise. This is due to the volume change caused by adding ash to the soil in various quantities. The shrinkage limit increased with a larger dose of GSA, which was related to an increase in the amount of fines in the sample. The CBR value of the soil increases slightly as the ash concentrations increase. It is possible that the minor increase in strength is due to a lack of calcium, it is necessary for the formation of calcium silicate hydrate, the most important component of strength growth. (P.Ranga Ramesh, 2019[15])
- Folagbade O P Oriola and Moses George investigated that Groundnut shell ash is used in natural soil resulted in a peak 7-day UCS value for WA compactive effort at SP of 526KN/m^2 at 6% GSA and 455KN/m^2 at 4% GSA content. TRRL (1977) specified 1710 KN/m^2 for base materials stabilization using OPC, but this rate fell short. They also failed to connect Ingles and Metcalf's requirement of 687–1373 KN/$m^2$for sub-base (1972). The peak soaking CBR values of 4% at SP and 4% at WA were achieved at 6 percent (GSA) and 0 percent (GSA), respectively. These values were low enough to meet the Nigerian General Specifications' requirements. Finally, the sample's durability tests failed to satisfy the required standard. (Falagbade O P orola, 2020[5])
- Ebin S Wilson and Sudha A R investigated that the addition of groundnut shell ash and glass powder to clayey soil improves its characteristics. The MDD of G.S.A. compacted soil increases significantly at 2% and then with the addition of glass powder, gradually reduces, the MDD of the soil-glass powder combination improved up to 6%, after which it dropped. At 6% groundnut shell ash as an addition, the highest UCC value of 0.756 Kg/cm^2 is reached. UCC values of 6 percent were obtained for both glass powder and GSA. For 6% groundnut shell ash, the maximum CBR value is 10.87%. (S Ebin, 2017[18]).
- Pratik V. Shah, Pavasiya Dishant and Harshil R. bhavsar investigated that The results show that when GSP + Soil is increased by 4%, the value of UCS and CBR increases as well. When the GSP is added, the value of Liquid Limit increases by 82.25 percent. The results of the Free Swell Index (FSI) demonstrate that the volume change has decreased dramatically from 90% to 25%. The FSI has been reduced by 72.22 percent. Because stabilized soil has the maximum UCS value yet the FSI is 63.63 percent, the ideal dose for the GSP was discovered to be 4% for using it as a foundation material in building. Because the soil has a value greater than 50%, it cannot be used. Because stabilized soil has the maximum CBR value, the ideal dose for the GSP was discovered to be 4% when using it as a foundation material for flexible pavement. At a 10% dose of GSP, the UCS and CBR values were observed to be lowered to 2.99 kg/cm2 and 8.45 percent, respectively. The values are lower than the black cotton soil's initial value; however the FSI is quite low, at 25%, when compared to the other dosages. The reduction in the value of UCS and CBR for a 10% dose of GSP is almost the same, i.e. 10.48 percent from the original value. (Shah P. D., 2020[19])

- In general, expansive soils aren't a problem if moisture levels are kept consistent throughout the soil. Furthermore, water fluctuation from subsurface and surface water layers can be controlled using horizontal barriers in the form of membranes around a building (Hanse, 2020[7]), vertical moisture barriers installed around the perimeter of the building (Zheng, 2019[21]), and an adequate drainage system (Qi, 2019[17]). Stabilization of soil with various chemical agents is still the most widely known way for eliminating the destruction caused by expansive or weak soils (Vijayan, 2020[20]). As a result, replacing expansive and weak soil with non expansive soil or improving mechanical qualities through soil stabilization is critical.

V. MATERIAL USE

1. SOIL

The soil was collected from Kaolinite clay obtained from Deepika Minerals and Chemicals in Siraspur, Delhi with latitude 28.76 and longitude 77.13.

2. GROUNDNUT SHELL ASH

A groundnut vendor in Rohini Sector 17, New Delhi, provided the groundnut shell. The ash was collected after the shells were burned on a metal sheet. A total of 35kg of shell was burned.

Groundnut shells compensate for around 21% of the weight of a dried peanut pod, showing that there is a large amount of shell leftover after groundnut processing. Groundnut shells accumulate as a result of increased production and are either burned or buried. Groundnut shell ash was obtained by burning of groundnut shell.

3. ONION PEEL POWDER

Onion is a widely available substance, and onion waste is generated in a variety of ways every day, all of which were successfully utilized in this experimental investigation. In both black cotton and expansive soil, onion peel ash improves strength. In this research onion peel was collected from local Delhi's vegetables mandi from Rohini sector 17 New Delhi.

4. SOIL PREPARATION

Soil was oven dried for 24 hours. The soil samples are prepared by mixing the base soil with 0%-40% onion peel powder and 0%-8% groundnut shell ash.

Onion peel powder and groundnut shell ash treated soil samples were prepared of determination Atterberg's limits, compaction behaviour, CBR, and UCS.

VI. EXPERIMENTAL ANALYSIS

1) PLASTICITY CHARACTERISTICS

1.1 LIQUID LIMIT

Liquid limit tests were conducted at various percentages of OPP and GSA as shown in Table 1.

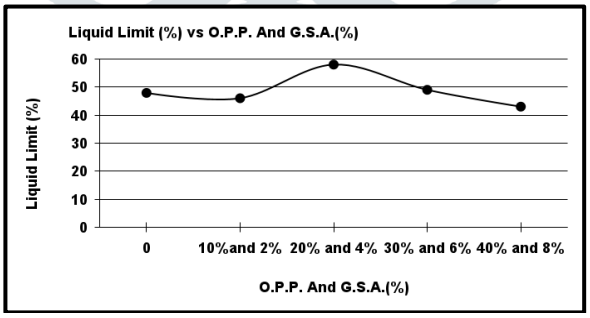

Fig. 6.1 % of OPP and GSA vs. Liquid limit

From the figure it was observed that the liquid limit was found to decrease from 47.9% at 0% GSA and 0% OPP to 46% at (10 %OPP and 2% GSA). After then, the liquid limit increases by 12% at (20% OPP and 4 %GSA) and continuously decreasing beyond (30% OPP and 6% GSA). So optimum dosage for liquid limit is 58% at (20% OPP and 4 %GSA).

1.2 PLASTIC LIMIT

Plastic limit were conducted at various percentages of OPP and GSA as shown in Table 1

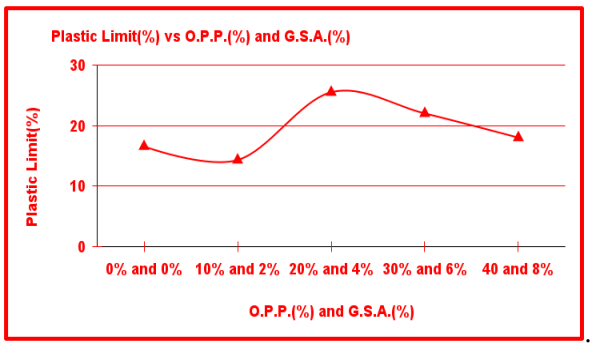

Fig. 6.2 % of OPP and GSA vs. Plastic limit

At 10% OPP and 2% GSA content, the plastic limit decreases by 2.25%. With the increase in GSA and OPP content since then, the plastic limit has increased up to 20%OPP and 4% GSA and then decreases. So optimum dosage for plastic limit is 25.5% at (20% OPP and 4 %GSA).

1.3 PLASTICITY INDEX

Plasticity index test were conducted at various percentages of OPP and GSA as shown in Table 1

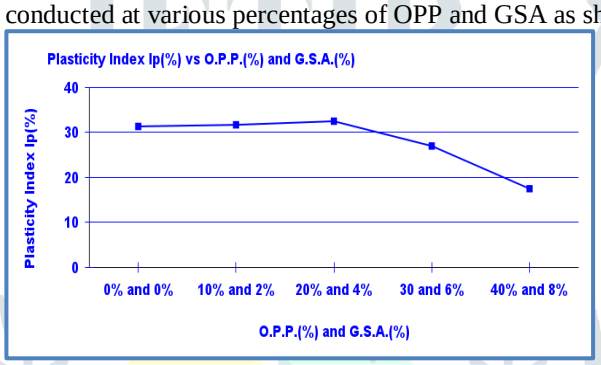

Fig. 6.3 % of OPP and GSA vs. Plasticity index

It was observed that the plasticity index increased from 31.35 % to 32.5 at 20% OPP and 4 % GSA. With the addition of the OPP and GSA content, it gradually decreases. The soil's plasticity index indicates its workability; lower the plasticity, the more workable the soil.

2) Compaction characteristics

2.1 Optimum Moisture Content and Maximum Dry Density

Compaction tests were conducted at various percentages of OPP and GSA as shown in Table 1

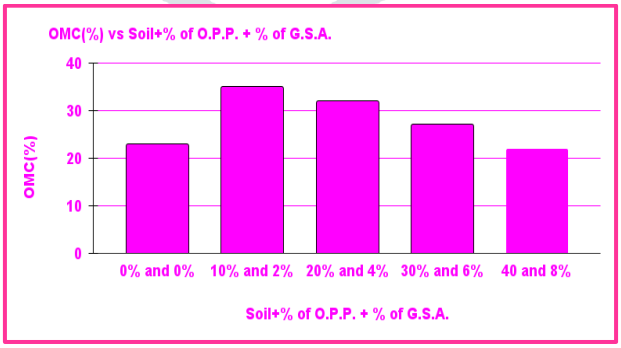

Fig. 6.4 % of OPP and GSA vs. OMC

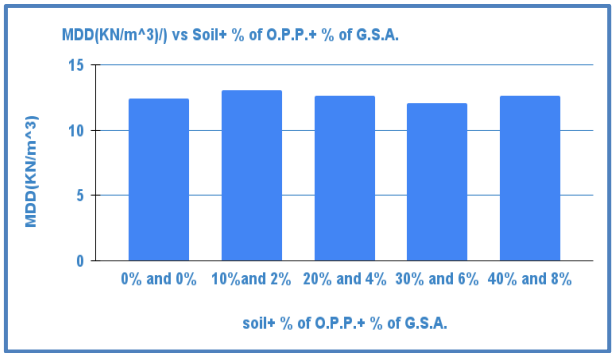

Fig. 6.5 % of OPP and GSA vs. MDD

At 10% OPP and 2% GSA, the highest variation in the OMC and MDD was seen, indicating that this was the optimum dosage.

3) Strength characteristics

3.1 California Bearing Ratio Test

Strength tests were conducted at various percentages of OPP and GSA as shown in Table 1

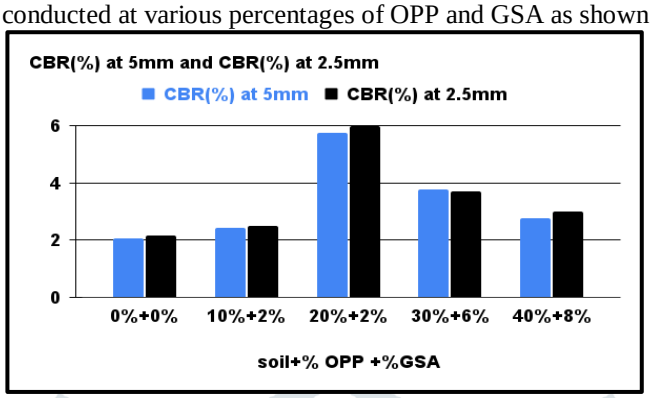

Fig. 6.6 % of OPP and GSA vs.CBR

The CBR test values for various percentages of onion peel powder and groundnut shell ash were observed to increase from 2.15% at 0% OPP and 0% GSA to 5.98 % at 20% OPP and 4% GSA, then decrease at 30% OPP and 4% GSA. It was found that 20% OPP and 4% GSA is the optimum dosage for CBR.

3.2 Unconfined Compressive Strength Test

The compressive strength of soil was conducted at various percentages of OPP and GSA as shown in Table

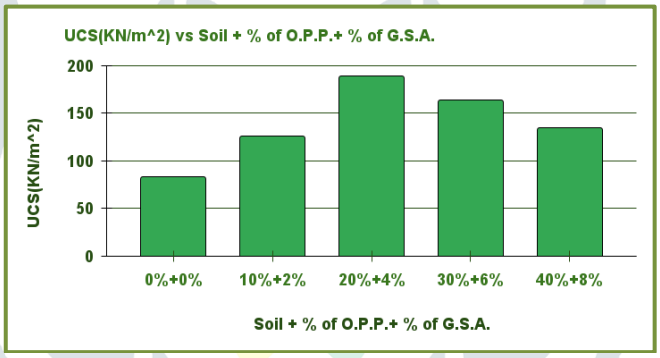

Fig.6.7 % of OPP and GSA vs. Compressive strength

The compressive stress increases as the onion peel powder and groundnut shell ash content increases, according to the UCS test results for varied percentages of OPP and GSA. At 30% OPP and 6% GSA, the compressive stress reached its maximum.

4) Test results

Table 1 Overall values of the tests conducted

Parameter	Soil +0%O.P.P. + 0% G.S.A	Soil +10%O.P.P. + 2% G.S.A.	Soil+ 20%O.P.P.+ 4% G.S.A.	Soil + 30% O.P.P.+ 6% G.S.A.	Soil + 40% O.P.P.+ 8% G.S.A.
Liquid Limit (%)	47.9	46	58	49	43
Plastic Limit (%)	16.55	14.3	25.5	22	18
Plasticity Index (%)	31.35	31.7	32.5	27	25
OMC (%)	23	35	32	27	22
MDD (KN/ m^3)	12.4	13.05	12.6	13.04	13
CBR (%)	2.15	2.51	5.98	3.7	2.99
UCS (KN/m^2)	82.98	125.89	188.35	163.08	134.52

VII. CONCLUSION

The first conclusion reached after analyzing the data is that stabilizing soil using waste products in combination with onion peel powder and groundnut shell ash produced better results. They are also the most efficient source of soil amendment for improving geotechnical properties and effective strength.

The objective of this experiment was to stabilize the geotechnical qualities of expansive soil. The following observations can be obtained from this research:

- The liquid limit was found to decrease from 47.9% at 0% GSA and 0% OPP to 46% at (10 %OPP and 2% GSA). After then, the liquid limit increases by 12% at (20% OPP and 4 %GSA). And continuously decreasing beyond (30% OPP and 6% GSA). So optimum dosage for liquid limit is 58% at (20% OPP and 4 %GSA).

- At 10% OPP and 2% GSA content, the plastic limit decreases by 2.25%. With the increase in GSA and OPP content since then, the plastic limit has increased up to 20%OPP and 4% GSA and then decreases. So optimum dosage for plastic limit is 25.5% at (20% OPP and 4 %GSA).

- It was observed that the plasticity index increased from 31.35 % to 32.5 at 20% OPP and 4 % GSA. With the addition of the OPP and GSA content, it gradually decreases. The soil's plasticity index indicates its workability; lower the plasticity, the more workable the soil.

- At 10% OPP and 2% GSA, the highest variation in the OMC and MDD was seen, indicating that this was the optimum dosage.

- The CBR test values for various percentages of onion peel powder and groundnut shell ash were observed to increase from 2.15% at 0% OPP and 0% GSA to 5.98 % at 20% OPP and 4% GSA, then decrease at 30% OPP and 4% GSA. It was found that 20% OPP and 4% GSA is the optimum dosage for CBR.

- The compressive stress increases as the onion peel powder and groundnut shell ash content increases, according to the UCS test results for varied percentages of OPP and GSA. At 30% OPP and 6% GSA, the compressive stress reached its maximum.

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