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EFFECT OF GROUND NUT SHELL POWDER ON SOIL STABILIZATION

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ABSTRACT

Various varieties of soil may be found across the world. The engineering features of soil are the most significant consideration in any building development. Construction on expanding soil is the most essential difficulty that civil engineers encounter. The expansive soil has typically undesired engineering properties, such as poor shear strength, plasticity, and compressibility; it expands when wet and shrinks when dry. Its characteristics can be enhanced with appropriate stabilizing procedures. Black cotton covers around 15% of the soil in India. Crops produced on black cotton soil include pea nuts, cotton, wheat, jowar, linseed, tobacco, castor, sunflower, and millets. In comparison, the peanut industry generates millions of tons of garbage. Nowadays, a key issue is "How to benefit from the industrial waste product."

Soil stabilization is performed in order to improve the engineering qualities of the soil. The rising expense of typical stabilizing chemicals, along with the need to economically utilize industrial and agricultural waste for positive engineering reasons, prompted an inquiry into the stabilizing potential of groundnut shell powder (GSP) in expansive soil.

This study looks at how to improve the geotechnical characteristics of expansive soil by performing various tests such as specific gravity, atterberg limit, compaction test, and California bearing ratio test to determine the properties of the untreated soil sample and then adding 5%, 7%, 9% and 11% ground nut shell powder by weight of soil. In this phase, only untreated soil testing are conducted. After receiving treated and untreated soil results, compare the untreated black cotton soil results to various percentages of ground nut shell powder results to determine the optimum amount of ground nut shell powder necessary to increase the stability of black cotton soil.

Keywords: Black cotton soil, Soil stabilization, Groundnut shell powder, California bearing Ratio.

1. INTRODUCTION

Soil stabilization is the process of improving soil's physical qualities. Stabilization may raise a soil's shear strength and manage its shrink-swell qualities, so enhancing a sub-grade's load bearing capability for pavement and foundation support. Soil stabilization refers to any physical, chemical, mechanical, biological, or combination approach of modifying natural soil to serve an engineering goal. To strengthen the soil, improvements are made to the weight bearing capacity, tensile strength, and overall performance of in-situ subsoil, sands, and waste materials. Soil stabilization refers to the process of enhancing the engineering qualities of poor soil with various stabilizing chemicals.,Through stabilizing the soil, permeability and,compressibility are reduced while shear strength increases, le ading to increased stability and improved soil bearing capacity.

A. Methods of Soil Stabilization:

a. **Mechanical Stabilization:** It's a technique to enhance the arrangement or gradation of soil. Two techniques for modifying soil characteristics are covered by mechanical stabilization: (i) arranging soil particles and (ii) applying soil gradation. Using materials that are properly balanced is especially crucial when building inexpensive roads. Subgrade soils can be improved by the use of the grading principle. Building bases and sub-bases is the primary use for the management of soil grading and low-grade aggregates. Many types of natural rock, gravel, sand, and artificial materials like slag, burned shale, etc. have been successfully employed in road building to ensure the mechanical stability of the materials.

b. **Dynamic Stabilization:** Using this technique, a massive weight of up to 45,000 kg is dropped from a height of 15 to 40 meters and let to fall naturally back to the earth. This forceful strike on the earth leaves its mark. Rapid draining causes liquefaction in cohesion-less soils, which is followed by settling. Radial cracks that occur around impacts in some soils allow for quick drainage.

c. **Preloading Method:** The most popular technique for preloading is the heaping of fill materials. Sometimes the material is removed entirely, sometimes only a portion of it is, and it might be used again in the same project for another preload or to build an embankment. Even though heaping fill material increases the risk of a base failure, this approach is typically used since it is less expensive for all kinds of structures and sites. The necessary weight for preloading can alternatively be applied to the ground by building a peripheral dike and filling the enclosed space with water, as an alternative to heaping fill. Typically, embankment loading is the most common preloading technique. Typically, it takes three to eight months from the start of embankment placement to the completion of load removal.

d. **Vibroflotation:** It is a useful method for simultaneously vibrating and saturating cohesiveness-less soils. This method was first used in Germany in 1939 to enhance the soils for construction foundations, and it originated in Russia in the middle of the 1930s.

e. **Stone Columns:** Granular piles, another name for stone columns, are often erected by vibration methods. A cylindrical vertical hole is created, and gravel backfill is added gradually. The material is then crushed using an appropriate tool, which also causes the material to shift radially. This produces a column of compacted stone that is a specific depth and diameter. Soft, inorganic cohesive soil is ideal for stone columns. To improve the density of loose sand deposits, they can also be applied.

f. **Injection grouting:** A crucial ground improvement method that may significantly increase soil stability and strength is grouting. up order to fill up spaces, compact the earth, and lessen soil settlement, cementations, or chemical grout, are injected into the soil. The grouting project design typically specifies the grouting techniques to be used in the project. The following criteria must be addressed when choosing a grouting technique:

- Soil or rocks of different characteristics should be treated individually.
- It should be possible to treat short sections of boreholes in any desired sequence.
- Leakage around the borehole should be prevented.

g. **Chemical Stabilization:** The process of chemical stabilization involves binding the soil particles together with a cementing agent—a chemical is usually the main additive—that is created by a chemical reaction that occurs inside the soil. The main additions that are frequently used include polymers, lime, salt, and lignin (which is a powdered form of sulphate liquid). In other circumstances, dispersants and aggregates are also used.

h. **Stabilization by Heating:** The clay minerals in a fine-grained soil undergo permanent changes when heated to temperatures between 400 and 6000 degrees Celsius. The soil stops being plastic, becomes less sensitive to water, and stops expanding. Additionally, the clay clods are turned into aggregates. Both kilns and in-situ slow-moving furnaces with a downward airflow can be used to bake soil. For mechanical stabilization, the artificial aggregates created in this way can be applied. In Russia, the heating approach is effectively used to stabilize deep, partially saturated loess deposits up to a depth of 12 meters. Increase cohesive soils' strength and reduce their compressibility by using this technique.

i. **Use of Geotextiles:** Geotextiles are synthetic fabrics that are permeable or porous and are utilized in conjunction with geotechnical elements like rock or soil as an essential component of man-made products, structures, or systems. Geotextiles can be woven, composed of mono-, multi-, or tape-filament, or they can be non-woven. Natural materials that can be used to create them include jute paper, wood shavings, and other things. The capacity of these fibers to be chemically, physically, and mechanically designed to fit specific geotechnical engineering applications is why geotextiles use them.

2. LITERATURE REVIEW

1. **Desiccation-Induced Volumetric Shrinkage Characteristics of Highly Expansive Tropical Black Clay Treated with Groundnut Shell Ash for Barrier Consideration[1].**

Journal of Department of Civil and Water Resources Engineering, Nigerian. (2019)

By George Moses, Roland K. Etim, John E. Sani, and Michael Nwude. In this study, the effects of varying amounts of ground nut shell ash (0%, 2%, 4%, 6%, and 8%) on compacted materials used as a hydraulic barrier in a wastewater containment facility are examined in extremely expansive black clay. They conducted a number of tests using both natural soil and natural black cotton soil that had had GSA added up to 8%. In the first fifteen days, the mould volumetric shrinkage strain value decreased for both the British Standard light and British Standard heavy, which were compacted at moulding water contents of -2, 0, 2, and 4% of their respective optimum. After that, the value increased with higher moulding water but decreased with higher compaction effort. Furthermore, the study's findings indicate that it is recommended that the proportion of GSA supernumerary be raised above the 8% GSA at which volumetric shrinkage is minimized.

It is assumed that the volumetric value will progressively decrease with the addition of 4% GSA.

2. A Comparative Study on the Effect of Glass Powder and Groundnut Shell Ash on Clayey Soil[2].

Journal of Department of Civil Engineering, St. Thomas Institute for Science and Technology, Trivandrum, India. (2017)

By Sudha A R and Ebin S Wilson.

The groundnut shell ash combined with black cotton soil stabilization was used in this study. For soil stability, they were adding different amounts of pulverized nut shell powder and glass powder to the soil at 0, 2, 4, 6, 8, and 10%. The outcome demonstrates that the free swell value of a natural soil is 15.25%, but when 6% ground nut shell ash is added, the value is only 2.91%, indicating a progressive decline in value.

Similarly, with 6% of GSA, a natural soil's CBR value increases to 2.17% from 1.67%. The value of a soil's unconfined compressive strength (UCS) after a 21-day curing time is 134 KN/m^2, which is higher than the 313 KN/m^2 of 6% GSA. The highest strength attained with the addition of 6% ground nut shell ash.

3. Stabilization Analysis of Black Cotton Soil by using Groundnut Shell Ash[3].

Journal of Applied Mechanics, Government Polytechnic, Junagadh, Gujarat. (2015).

By Mr. N. V. Gajera and Mr. K. R. Thanki.

The groundnut shell ash combined with black cotton soil stabilization was used in this study. The outcome demonstrates that, for the natural soil, the liquid limit and plasticity index values are 83.36% and 38.92%, respectively. Similarly, with a 10% GSA, the values are 103.71% and 75.88%, respectively. Furthermore, the free swell value of a natural soil is 15.25%, but when 10% ground nut shell ash is added, the value is only 2.91%, indicating a progressive drop in value with the addition of GSA.

Similarly, with 10% of GSA, a natural soil's CBR value increases to 2.17% from 1.67%. In contrast to 313 KN/m^2 of 10% GSA, the strength of a soil for UCS (unconfined compressive strength) after a 21-day curing time is 134 KN/m^2. The highest strength attained after 10% ground nut shell ash was added.

4. Soil Stabilization by Groundnut Shell Ash and Waste Fiber Material[4].

Journal of PACE Institute of Technology and Sciences. (2015).

By T. Murali Krishna and Sd. Shekun Beedi.

Ground nut shell ash (3%, 6%, and 9%) and waste fiber reinforcement (0.05%, 0.1%, and 0.15%) are used in this study.

Using groundnut shell ash percentages of 3%, 6%, and 9% in a soil sample, a direct shear test yielded results that increased cohesiveness by 7.11%, 14.22%, and 20.89%, respectively. The increase in unconfined compression strength was determined to be 24.60%, 44.26%, and 59.01%, respectively, based on an unconfined compressive strength test conducted on a soil sample containing groundnut shell ash at concentrations of 3%, 6%, and 9%.

The increase in cohesiveness was determined to be 7.11%, 14.22%, and 20.89%, respectively, based on a direct shear test conducted on a soil sample with groundnut shell ash percentages of 3%, 6%, and 9%. Based on an unconfined compressive strength test conducted on a soil sample containing 3%, 6%, and 9% groundnut shell ash, the corresponding increases in unconfined compression strength were determined to be 24.60%, 44.26%, and 59.01%.

The highest strength attained with the addition of 9% ground nut shell ash.

5. Groundnut Shell Ash Stabilization of Black Cotton Soil[5].

Journal of Dept. of Civil Engineering, Nigerian Defense Academy, Kaduna, Nigeria. (2010).

By Oriola, Folagbade and Moses, George.

According to the protocols described in BS 1377 (1990) and BS 1924 (1990), respectively, index tests were conducted on the natural and stabilized soils in this study. For the stabilized soil specimens, step percentages of groundnut shell ash by dry weight of soil (0, 2, 4, 6, and 8%) was introduced into the soil. In compliance with the Nigerian General Specification (1997), which mandates that specimens be cured in the dry for six days and soaked for twenty-four hours prior to testing, the soaked California bearing ratio test technique was implemented.

According to the results, the natural black cotton soil was categorized as CL in the Unified Soil Classification System (USCS) and AASHTO, respectively. A peak 7-day UCS value at Standard Proctor of 455 KN/m^2 at 4% GSA content and 526 KN/m^2 at 6% GSA content for West African Standard compactive effort were obtained by treating the natural soil with groundnut shell ash. The highest strength attained with the addition of 6% ground nut shell ash.

3. MATERIAL

A healthy leguminous crop, groundnuts are primarily farmed for their oil and seeds globally. The stuff left behind after groundnut seeds are extracted from their pods is known as groundnut shells. This is a common byproduct of agro-industrial waste that degrades extremely slowly in the environment. On the other hand, a variety of bioactive and functional components found in groundnut shells are advantageous to humans.

The shells make up around 30% of the legume's weight overall, and each kilogram of groundnuts yields 200–300 grams of shells.

Although the globe produces around 11,000,000 tons of these wastes from the peanut industry annually, applications for them are still in their infancy. Ground nut shells are used in the manufacturing of hydrogen, bioethanol, biodiesel, construction materials, carbon Nano sheets, heavy metal adsorption, paper, and color degradation.

A. Chemical Composition of Groundnut Shell Powder:-

Chemical Composition	% by Weight
SiO_2	27.01
Al_2O_3	6.58
Fe_2O_3	0.53
CaO	9.43
MgO	5.57
SO_3	1.79
K_2O	20.13
P_2O_5	1.95
MnO_2	0.34
TiO_2	0.68
LOI	23

B. Market Survey of Ground Nut Shell Powder:-

Country	Area(Lakh hector)	Production (Lakh tones)	Yield (Kg/hector)
China	44.04	149.38	3390
India	55.20	61.06	1105
Nigeria	25.36	28.26	1119
USA	5.17	19.67	3796
Myanmar	8.40	13.36	1590
Senegal	10.30	10.16	975
Indonesia	6.43	7.7	1240
Niger	6.86	3.22	466
World	240.05	375.11	1562

4. NEED OF PRESENT STUDY

Black cotton soil contracts during the dry season, causing uneven building settlement, cracks, swelling and shrinkage problem occur during different weather.

So it is essential to enhancing the strength or carrying capacity of black cotton soil through controlled compaction, proportioning, and/or the addition of the appropriate admixtures or stabilizers. For achieving stabilization, the different agricultural wastes are used like a fly ash, bagasse ash, rice husk ash and ground nut shell powder.

By using previous research paper, we are using a ground nut shell powder for black cotton soil stabilization. Around 25-30% of the ground nut by weight the waste produces in ground nut shell industries and its throw as a waste so we are used in this for improving the bearing capacity of the black cotton soil.

5. CONCLUSION

A. Summary of Black Cotton Soil All Experiment:

Sr. No	Tests	Parameter	Result
1	Atterberg's Limit	Liquid Limit	74.07 %
		Plastic Limit	31.67 %
2	Standard Proctor	Maximum Dry Density	1.79 gm/cm^3
		Optimum Moisture Content	15.60 %
3	Specific Gravity Test	Specific Gravity	2.66
	California Bearing Ratio Test	CBR-Unsoaked	5.88 %
4	Free Swell Index Test	FSI	82.22 %

B. Summary of BCS + 5% of GNSP All Experiment:

Sr. No	Tests	Parameter	Result
1	Atterberg's Limit	Liquid Limit	68.26 %
		Plastic Limit	34.20 %
2	Standard Proctor	Maximum Dry Density	1.80 gm/cm^3
		Optimum Moisture Content	13.80 %
3	Specific Gravity Test	Specific Gravity	2.67
	California Bearing Ratio Test	CBR-Unsoaked	6.37 %
4	Free Swell Index Test	FSI	72.22 %

C. Summary of BCS + 7% of GNSP All Experiment:

Sr. No	Tests	Parameter	Result
1	Atterberg's Limit	Liquid Limit	63.70 %
		Plastic Limit	35.11 %
2	Standard Proctor	Maximum Dry Density	1.83 gm/cm^3
		Optimum Moisture Content	13.00 %
3	Specific Gravity Test	Specific Gravity	2.66
	California Bearing Ratio Test	CBR-Unsoaked	7.35 %
4	Free Swell Index Test	FSI	64.44 %

D. Summary of BCS + 9% of GNSP All Experiment:

Sr. No	Tests	Parameter	Result
1	Atterberg's Limit	Liquid Limit	60.70 %
		Plastic Limit	35.42 %
2	Standard Proctor	Maximum Dry Density	1.86 gm/cm^3
		Optimum Moisture Content	12.40 %
3	Specific Gravity Test	Specific Gravity	2.66
	California Bearing Ratio Test	CBR-Unsoaked	8.82 %
4	Free Swell Index Test	FSI	57.41 %

E. Summary of BCS + 11% of GNSP All Experiment:

Sr. No	Tests	Parameter	Result
1	Atterberg's Limit	Liquid Limit	57.37 %
		Plastic Limit	36.14 %

2	Standard Proctor	Maximum Dry Density	1.84 gm/cm^3
		Optimum Moisture Content	13.30 %
3	Specific Gravity Test	Specific Gravity	2.66
	California Bearing Ratio Test	CBR-Unsoaked	8.33 %
4	Free Swell Index Test	FSI	55.56 %

By performing the various tests with a different percentage of a ground nut shell powder the result shows that the gradually increase the 5%, 7% and 9% after that the using the 11% of ground nut shell powder its CBR value goes to down so it is conclude that the maximum soil stability is improved by adding up to 9% of ground nut shell powder in black cotton soil.

6. REFERENCE

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