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Strength Capacity of Clay Soil Modified With Geosynthetics and Coconut Coir Fibre

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Abstract

The strength capacity of the Clay soil modified with Geosynthetics and Coconut fibre. The soil samples were taken from Egbelu Ogbogoro Obio Akpor Local Government Area. The soil samples from the preliminary test showed that the soil is classified as an A-7-5 soil. The cohesion value for the triaxial test increases with the longest cohesion occurring at 8% for coir fiber, 39.31kpa and 6% for Geosynthetics 40.33kpa. The internal friction angle increases with the maximum friction angle occurring at 10% for coir fibre 14.57° and 4% of Geosynthetics 13.03°. The maximum safe bearing capacity of the specimen occurred at 10% for both modifying agents. The clay soil with coir fiber increases the CBR value from 3.53% for 0% unsoaked and 2.06% soaked to 11.35% for 10% unsoaked and 9.22% soaked, while Geosynthetics increased the CBR of the soil at 16.70% unsoaked condition and 11.21% for soaked condition. However, the coir fiber and Geosynthetics of unsoaked and soaked condition meet the minimum requirement oratiof California bearing of 6. The compressive strength (UCS) also improves the strength of the clay soil and the maximum UCS value at 10% for both additives. Based on the test results. Both Geosynthetics and coconut coir fibre modified with soil have proved that they can be used for stabilizing the subgrade soil for the stability of the foundation of structures in Civil Engineering.

Keywords: ***Cohesion, Internal friction angle, Safe bearing capacity, California bearing ratio (CBR), unconfined compressive strength (UCS)***

1.0 Introduction

Clay soil's strength capacity is critical in geotechnical engineering and civil engineering structure construction. Surendra (2022) states that the soil's strength capability is defined by its shear strength. According to Olaniyan & Akolade (2014), shear strength refers to the highest level of resistance or stress that a certain soil can withstand before it fails under incorrect surface loading. The soil's shear strength is characterized by its cohesiveness and frictional angle. Civil engineering construction uses clay soil as a subgrade for its foundations.

Subgrade is the native soil beneath the ground. Positive or negative values of soil index properties and engineering properties can influence the subgrade. Soil index properties are the characteristics of soil that are used to categorise and determine its engineering features. These include grain size, liquid limits (LL), plastic limits (PL), plastic index (PI), void ratio, air content, and water content. The subgrade's primary role is to ensure the foundation's necessary stability. In the event of encountering a problematic or weak subgrade deposit, it can be replaced with a high-quality soil that meets the required CBR values. Alternatively, you can reinforce chemical or geosynthetic materials into the soil to stabilize the subgrade. Soil stabilization and reinforcement are effective methods for enhancing soil strength and stability. When the subgrade soil is weak or unable to withstand environmental pressures or traffic loads, it causes deformation in the pavement or structures. Geosynthetics can enhance the performance of the unpaved road or structure in such cases. This can be achieved by increasing the lifespan, reducing maintenance costs, and decreasing the thickness of the road.

Stabilization of soil is a standard procedure for road construction. There are two main categories into which soil stabilisation methods fall: mechanical and chemical. Mechanical stabilization involves blending soils of varying degrees to alter the soil's grading. (Anjan 2019; Kothari and Mamayes 2018). Bryan (2020) explained the difference between soil stabilization and reinforcement. They are often used interchangeably when discussing geogrids used for civil engineering applications. However, there are key differences in their definitions that have far-reaching implications. Bergado et al. (2020) used geotextile plaxis software to look at how the system behaved while building and when it failed of a geotextile-reinforced embankment that was put down on soft soil. The results demonstrated that the geotextile could lessen the embankment's plastic deformation.

Ogutidare (2018) described the use of geotextiles for soil stabilization, as well as the main use types of soil clay A and clay B of lateritic A7–5 and A7–6. The American Association of State Highway and Transportation Officials (AASHTO) deems these subgrade materials subpar according to the California Bearing Ratio Test. After reinforcement with non-woven geotextile, the CBR values of the two soil samples increased to 15% and 21% in the unsoaked condition, respectively, compared to 4% and 7% in the absence of reinforcement. This suggests that these samples are suitable for subgrade, as defined by the Federal Ministry of Works' general specification (1997). Soil types found below grade. Abhijith (2015) used coir fibre to improve the subgrade soil. The CBR test establishes a correlation between coir fibres varying from 0.5 to 3 cm and 2 to 8% of the total weight. As a result, introducing soil at two-thirds of the depth appears to be more effective.

Low-bearing cohesive soil is problematic for the foundation of highway pavement, building structures, and hydraulic structures. However, there is an urgent need to improve the soils with geosynthetic materials and coconut coir fibre as a replacement to reinforce the weak subgrade soil. Geogrid type geosynthetics can be costly, but you can substitute them with woven slit-film geotextiles or non-woven geotextiles to boost the CBR values and achieve the highest level of soil compaction. Local geotextile materials, such as coconut coir fibre, can also enhance the strength of weak subgrade soil. Coconut coir fiber will first go through a mechanical process to produce coir geotextile material to stabilize and reinforce the road's subgrade soil.

Geosynthetics with high tensile strength, as reported by Ruauan et al. (2023), are valuable in the design of many civil engineering projects, especially those involving soft soil. By increasing the strength of the reinforcement mass, the use of reinforcement can improve the stability of soil structures like roads, retaining walls, embankments, and slopes by reducing horizontal deformation and adding shear stress to the soil mass. Gavthri (2019) discussed this in an experimental setting. Examining Geogrid. This research on a reinforced subbase over a soft soil basis yields the following findings: In wet and dry environments, soil-geogrid interfaces improve CBR strength and penetration resistance. With no reinforcement, the CBR of the subgrade soil is 3.6%; however, by positioning the geogrid 0.2H from the top, the CBR value increased to 8.7%. Adding a single layer of geogrid to the top of layer 3 improves the geogrid's performance in both wet and dry conditions.

Manumem (2020) explained the stability of the Geogrid reinforcement embankment on soft soil and that the reinforcement by Geogrid helps to improve the embankment stability and guarantee more uniform settlement. Vivek et al. (2018) stabilized the soil using coir geotextile and described its use, providing knowledge about the enhancement of soil properties with the results of CBR and shear tests carried out before and after the treatment. Janakiraman et al. (2019) gave more details on natural and artificial geotextiles for strengthening subgrade soil and evaluated the effect of reinforcement of geotextiles on subgrade soil.

Lakshm et al. (2018) detailed the use of coconut coir fibre to enhance the subgrade strength properties of clayed sand. Janakiraman et al. classified soils according to their index properties; they found that different types of soil had different percentages of CCF and different lengths of CCF (ranging from 1 cm to 5 cm). Their goal was to find the optimal percentage and length of CCF for achieving maximum strength in the unconfined compression test and the soaked CBR test. The results showed that soils with 1.2 CCF and lengths ranging from 2 cm to 3 cm had a UCS strength increase of 43.2 and 47.4, respectively, which is about four times that of unreinforced soil. Adding organic or synthetic fibres to soil is an important way to make it stronger, as Gbengamo et al. (2016) explained in their study of the geotechnical properties of soil mixtures, which included coconut coir fibres. The addition of coconut coir fiber enhanced soil properties such as maximum density, cohesiveness, angle of material friction, and California bearing ratio. CBR

Previous studies on the use of geosynthetics and coconut coir fibre for soil stabilization have mainly focused on modifications with respect to road pavements and foundations, with a limit to the CBR test. Therefore, the bridge between the present study and the previous is the use of geosynthetics and coconut coir fibre, which will be extended beyond the CBR test. These include UCS and triaxial tests for stabilization of cohesive soil with respect to strength capacity for stability.

This work aims to investigate the strength capacity of the clay soil modified with geosynthetics and coconut coir fibre. On this basis, the following objectives are structured;

i. To determine the influence of Geosynthetic and coconut fiber on the cohesion of the soil.
ii. To determine the influence of Geosynthetics and Coconut coir fibre on the Angle of internal friction of the soil.
iii. To determine the safe bearing capacity of the soil with vary contents of Geosynthetics and Coconut coir fiber.
iv. To determine the CBR values of the soil for varying contents of Geosynthetic and coconut coir fibre.
v. Evaluation of UCS of soil with varying Geosynthetics and coconut coir fibre contents.

2.0 Materials and Methods

2.1 Materials

The materials to be used in the research include clay soil, Geosynthetic products and coconut coir fibre.

2.2 Methods

The methodology for the research includes

2.2.1 Material sampling

In this study, the clay soil samples were obtained from Egbelu Town, Ogbogoro road, Obio Akpor Local Government Area of Rivers State, Nigeria. The disturbed soil sample was collected at 0.2-1.00 depth below the ground surface. The geosynthetic materials were obtained from Mile 3 market and MaccaFeeri Company, Abacha Road, Port Harcourt. The native coconuts were also obtained from Mile 3 Market, Port Harcourt. The material sample was taken to the civil engineering laboratory of Rivers State University.

2.2.2 Laboratory experiment

This involves testing material used to determine the following

i. Traixial test
ii. California Bearing Ratio
iii. The Unconfined Compressive Strength
iv. Also include specific gravity, particle size distributions, and moisture contents.

2.2.3 Sample Preparation

Following the guidelines laid forth by the ASTM and the BS for soil testing, all laboratory tests and data analysis were conducted in compliance with these standards. Soil cohesiveness, moisture, particle size distribution, unconfined compressive strength, and California were first evaluated. Products made of geosynthetics and coconut coir fibre that were reinforced with soil at2%,4%,6%,8%, and 10% underwent triaxial testing and bearing ratio evaluations.

2.2.4 Physio-Chemical Analysis

2.2.4.1 Moisture of water content (w%)

In this method, a soil sample was put into a container, weighed in the sampled (moist) 105^o-110^o (221^o-230^oF) to constant weight for 24 hours for samples.

The moisture content percentage is calculated based on dry soil weight using this formula

Percentage moisture (W %) = $\frac{MW}{MS} \times 100$ (1)

= wt of wet soil- oven dry soil wt/oven dry soil weight

An empty container (M1) was weighed first. The soil sample was then put in the container as (M_2).

The container with the soil sample was put in an oven at a controlled temperature of 105^o-110^oc ($221^o 230^o$F) for 24 hours. Therefore, the container dried soil (m3) was repeated three times.

2.2.4.2 The specific gravity

After cleaning and drying the pyrometer, screw its cap firmly. Measure its mass (M1) to the closest 0.1g. Line up the cap and pyrometer vertically so that the cap is screwed to the same mark every time. Remove the cap and add about 200g of oven-dried soil to the pyrometer. Screw on the tops to find out the M2. Remove the cap and fill the pyrometer with enough de-aired water to cover the dirt. Secure the cap and give the contents a good shake. To extract the trapped air, attach the pyrometer to a vacuum pump and adjust the setting for clay soil to around 20 mm. Then, turn off the vacuum pump. Pour about three-quarters of the water into the pyrometer.
To prevent further air bubbles from rising to the water's surface, you should reapply the hoover for around 5 millimeters. Submerge the pyrometer in water until it reaches the mark. Get its mass (in cubic metres) after drying it outdoors. Once the pyrometer is empty, make a note of the temperature of the contents. Sponge it clean and pat it dry. Put just water into the pycnometer, screw the lid on until it reaches the mark, wipe it dry, and then measure its mass (M4).
So, specific gravity (Gs) is the product of a material's density and a standard material's density.

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Specific gravity of soil is determined using the relation where

M1=mass of empty pycnometer
M2 =mass of the pyrometer with dry soil
M3 =mass of pyrometer and soil and water
M4 =mass of pyrometer filled with water only

Therefore Gs = $\frac{Vsolids}{V\,water} = \frac{Ms}{Vspw}$ (2)

Specific gravity of soil (Gs)

$$= \frac{M2-M1}{(w4-w1)-(w3-w2)} \quad (3)$$

For

$$GF = Gs = \frac{M2-M1}{(w3\text{-}w1)-(w4-w2)PT} \qquad (4)$$

2.2.4.3 Atterberg limits consists the liquid limit and plastic limit.

The liquid limit is the water content at which the soil has such a small shear strength that it flows to a groove of standard width when jarred in a specific

2.2.4.3.1 Liquid Test method

A uniform substance was created by mixing approximately 20 grams of damp soil with distilled water for the liquid test. This sample was filtered through sieve NO. 425pm. A portion of soil sample 1 wet was deposited in a brass cup that was half-filled, i.e., the LL device, and the top was forced up parallel to the base. A grooving implement was used to cut a 2mm groove through the centre of the soil and into the brass cup or dish. Figure 1 illustrates that the cup was elevated by 10mm and then lowered onto a rubber base until the groove's bottom had closed for a distance of 10mm. The crevice closure was the point at which the number of strikes was recorded. This procedure was repeated for a variety of strikes at each closure of the crevice, and a sample should be collected for moisture content deamination. The examination was administered an additional four times.

2.2.4.3.2 Plastic Limit

Dry soil of about 30g is sieve through sieve 4254qm and mixed with water and is moulded into a ball 5g of the wet soil is then roll with the tap of figure on the glass plate to form a thread. The soil is further rolled until the tread becomes 3mm. Thereby the soil is recommended and rolled up again until the thread start crumbling at a diameter of 3mm finally a portion of the soil is taken for moisture content determination. The test is repeated 4 more times. The plasticity index refers to the amount of water to be added to change a soil from its plastic limit to its liquid limit. Therefore;

Plasticity index = liquid limit LL-Plastic Limit PL.

2.2.4.3.3 Particle Size Distribution

Soil sample was over dried and weighed. The weighed sample was then placed in the set of sieves and shaken for five minutes. Finally, the material retained on each sieve was weighed. The calculation is cumulative percentage passing on each sieve is obtained by cumulative per cent retained on each sieve from 100 percent from each sieve six in addition.

2.2.4.3.4 Compaction Test

Combine approximately 3 kilogrammes of air-dried soil with 5% of its weight in water. The mixed soil should be compacted in three layers in a mould of known weight (with a collar attached), with each layer being compacted with 25 blows of the 2.5kg lammar with a drop of 300mm (standard Aashto) or in five layers in a mould of known weight (with a collar attached), with each layer being compacted with 25 blows of the 4.5kg hammon with a drop of 450 (modeialAashio). The proctor and modified proctor are named after R.R. procher of Los Angeles. The soil was levelled and weighed after the collar was removed.

Extrude soil from the mould, and the moisture content was determined to break up compacted soil, and it was mixed with the rest of the sample. More was added and mixed thoroughly, and repeated steps 2 to 4. Repeat steps 2 to 5 several times, and the weight of compacted soil reached it maximum and decreased. Calculation of compaction

$$Dd = \frac{B}{1+W} \quad (5)$$

B = Bulk density, W = Moisture content

How to get the optimal moisture content (omc) and maximum dry density (MD) from a graph of Dd versus W).

2.2.4.3.5 Unconfined compressive strength

Unconfined compression was one of the easiest and fastest ways to test saturated clays right away. A unique triaxial test cask with zero lateral pressure

$\sigma_2 = \sigma_3 = 0$. Only vertical load is applied, and the rubber membrane is dispensed. The apparatus to be used are specimen trimmer, and accessories, scale, balance suture to 0.09, oven, sample ejector, evaporating dish, rubber membrane, rubber rings and axial load through proving ring. Unconfined compression strength test for coconut coir fibre and geosynthetics reinforced with soil of 2%, 4%, 6%, 8% and 10%.

2.2.4.3.6 California Bearing Ratio (CBR) TEST

Normally, the curve is correct by drawing a tangent at the steepest point and producing it back to the unit penetration axis at a point regarded as the origin of the penetration scale for the corrected curve. The plunge resistance at 2.5mm is expressed as a percentage of 13.24kw and the plunger resistance at 50mm is expressed as percentage of 19.96kw. The higher of these two percentages is taken as the CBR value of the tested soil or aggregate formulae

$$CBR = \frac{100XI}{3000} \text{ or } \frac{100X2}{4500} \quad (6)$$

Are used when loads are in pounds per square inch (Psi) and

$$CBR = \frac{100XI}{1000} \text{ or } \frac{100X2}{1500} \quad (7)$$

When loads are in kW, Newton (kw) is in both cases. x1 is the load at 2.5mm (0.1 inches) penetration, and x2 is the load at 5.0mm (0.2 inches) penetration.

2.2.4.3.7 Triaxial Test

i. In a typical Triaxial shear test, a sample in the shape of a cylinder was placed between two rigid caps and then covered with a latex membrane.
ii. After that, it was placed in a Perspex cell with water.
iii. The sample was later packed by exerting cell pressure with water passed through the Perspex tube.

2.2.4.4 Determine of unconfined compressive and bearing capacity properties

3.3.1 Unconfined compressive strength is aimed at the following equation

$$E = \frac{\Delta L}{LO} \quad (8)$$

Where

AL = change in specimen, as read in strain dial.

LO = Initial length of the specimen.

The average cross-sectional Area, A, is determined by the following

$A = \frac{\Delta L}{1-\varepsilon}$ (9)

A_o = initial average area of specimen

The compressive stress is $\sigma = \frac{P}{A}$ (10)

P represents the compressive force. A plot is created between the coordinates 6 and E. The highest stress obtained from the curve provides the value of unconfined compressive strength. In cases when no maximum stress is reached, the unconfined compressive strength is determined as the stress at 20 per cent strain availability.

2.2.4.5 Bearing Capacity

Cohesion, $C_u = \frac{q_u}{2}$ (11)

Therefore, unconfined compressive strength, $q_u = 2c_u$

The ultimate bearing capacity of the soil is given as

$q_u = CN_c + qN_q + {}^{1}/_{2}\gamma B\ N_\gamma$ (12)

For cohesion soil

$N_\gamma = 0, N_c = 5.7\ , N_q = 1$

Therefore $q_u = CN_c + q$

Where; $q\ = \gamma D_f$ (13)

D_f = depth of foundation

$N_c\ N_q\ N_\gamma$ = bearing capacity factor.

3.0 Results and Discussion

3.1 California Bearing Ratio (CBR)

3.1.1 CBR Test for Coir Fibre

Table 1: Summary for California Bearing Ratio Test Result of Coir Fibre for Unsoaked (US) and Soaked (S) Condition as a Modifying Agent

%F	$(T1)_{US}$	$(T2)_{US}$	$(T3)_{US}$	$(AV)_{US}$	$(T1)_S$	$(T2)_S$	$(T3)_S$	$(AV)_S$
0	3.47	3.53	3.58	3.53	1.98	2.04	2.15	2.06
2	7.49	7.38	7.56	7.48	7.16	7.05	7	7.07
4	8.1	8.27	8.05	8.14	7.44	7.27	7.38	7.36
6	8.6	8.47	8.87	8.65	7.61	7.66	7.55	7.61
8	10.03	9.7	10.36	10.03	8.82	8.6	8.71	8.71
10	10.86	11.57	11.63	11.35	9.37	9.26	9.04	9.22

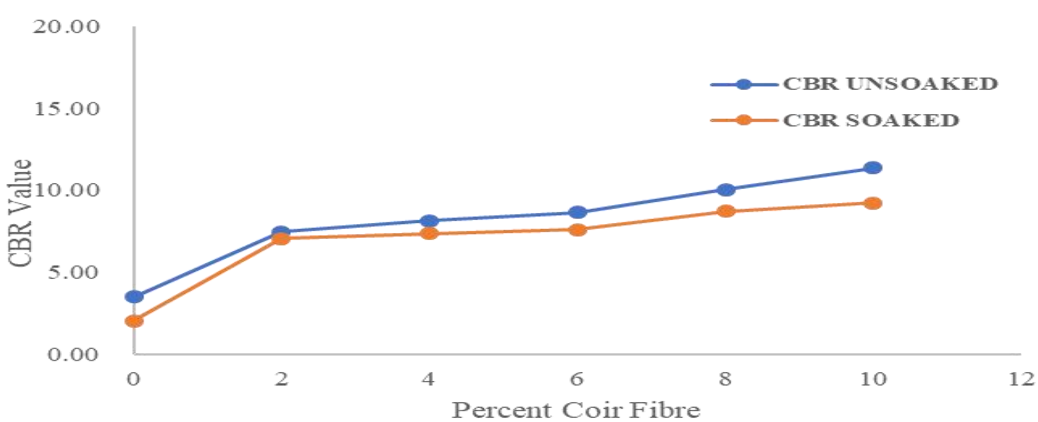


Fig.1: Summary CBR value for Coir fibre unsoaked and soaked

As the percentage of coir fibre (%F) and geosynthetics in the sample grew, the CBR values rose relative to the 0% soil (3.53% CBR value). The highest CBR value of 9.22% for wet and 11.35% for unsoaked conditions was achieved at 10% coir fibre. For Geosynthetics, the maximum CBR Value occurred at 10% for both soaked and unsoaked, 11.21% and 16.88% respectively.

3.1.2 CBR Test for Geosynthetics

Table 2: Summary for California Bearing Ratio Test Result of Geosynthetics for Soaked Condition as a Modifying Agent

%G	$(T1)_{US}$	$(T2)_{US}$	$(T3)_{US}$	$(AV)_{US}$	$(T1)_S$	$(T2)_S$	$(T3)_S$	$(AV)_S$
0	3.47	3.53	3.58	3.53	1.98	2.04	2.15	2.06
2	8.93	9.04	9.15	9.04	6.94	7.55	7.33	7.27
4	10.31	10.2	10.36	10.29	8.98	8.76	8.6	8.78
6	11.63	11.68	11.55	11.62	8.82	9.31	9.09	9.07
8	12.01	12.18	11.74	11.98	9.42	9.26	9.53	9.4
10	16.75	16.81	16.53	16.70	10.86	11.13	11.63	11.21

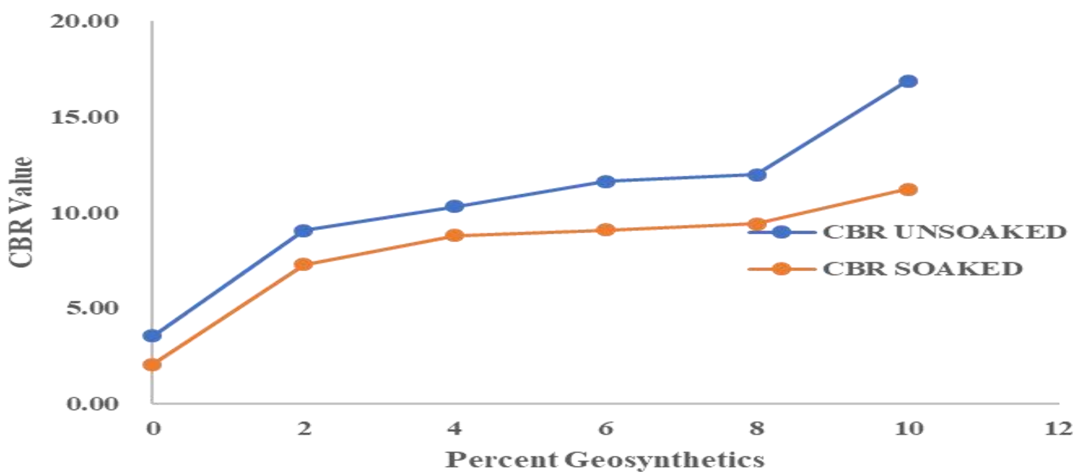


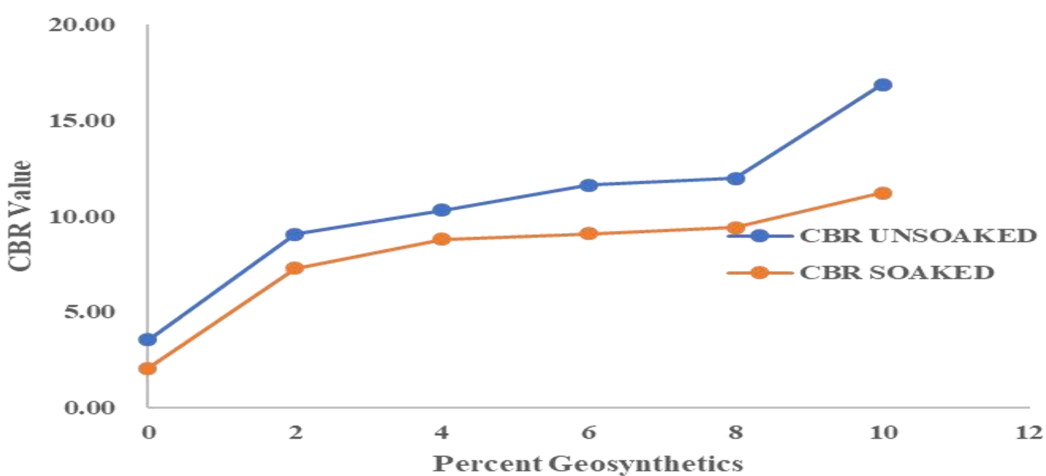
Fig.2: summary CBR value for Geosynthetics unsoaked and soaked

Geosynthetics for unsoaked and soaked conditions, respectively. CBR value increased with the addition of Geosynthetics to the soil from 2% to 10%. However, this CBR value did meet the minimum CBR value of 6% for a subgrade as specified by the Nigerian General Specification (1997). Therefore, the modification with Geosynthetics can be used as a standalone stabilizer to improve CBR for subgrades.

3.2 Cohesion Determination

Table 3: Cohesion Determination for Coir Fibre (F) and Geosynthetics (G) as a modifying agent

%F/G	$(T1)_F$	$(T2)_F$	$(T3)_F$	$(AV)_F$	$(T1)_G$	$(T2)_G$	$(T3)_G$	$(AV)_G$
0	25	29	30	28	25	29	30	28
2	26	28	29	27.67	28	26	29	27.67
4	29	33	32	31.33	35	32	32	33
6	33	36	28	32.33	43	40	38	40.33
8	37	40	41	39.33	39	35	42	38.67
10	35	32	38	35	35	39	41	38.33



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0	25	29	30	28	25	29	30	28
2	26	28	29	27.67	28	26	29	27.67
4	29	33	32	31.33	35	32	32	33
6	33	36	28	32.33	43	40	38	40.33
8	37	40	41	39.33	39	35	42	38.67
10	35	32	38	35	35	39	41	38.33

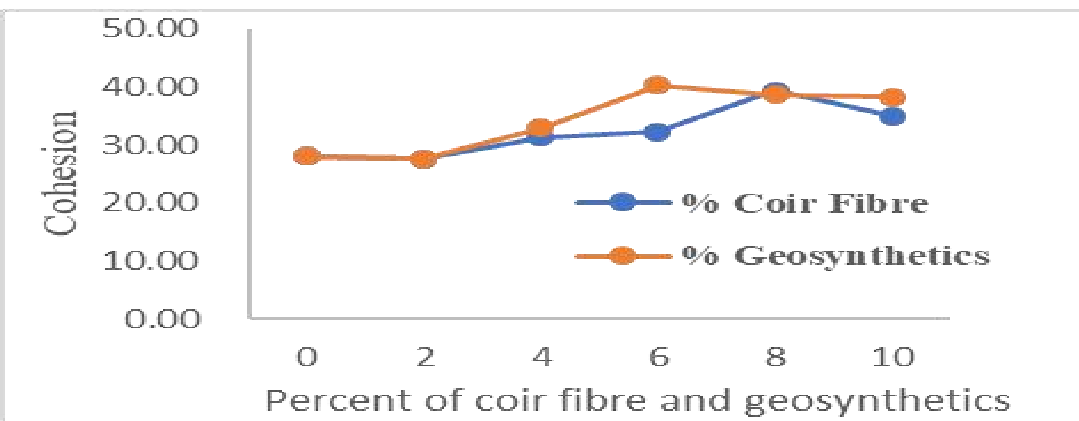

Fig 3: Combined graph of Cohesion value against the Percentage Coir fibre and Geosynthetics

The results for the cohesion value of the soil show that the cohesion value at 2% decreased when compared with 0%. As the percentage of coir fibre increased from 4%, 6% and 8% so did the cohesion value increase 31kpa, 32kpa and 39kpa, respectively. At 10% the cohesion value decreases to 35kpa. This result implies that 8% the undrained cohesion of the specimen is higher. While the cohesion value of the soil studied with the Geosynthetics sample shows that the cohesion value at 2% decreased when compared with 0%. As the percentage of geosynthetics increased from 4%, and 6% so did the cohesion value increase 33kpa and 40kpa respectively. 8% and 10% the cohesion value decreased, 39kpa and 38kpa, respectively. This result implies that 6% the undrained cohesion of the specimen is higher.

3.3 Internal Friction Angle

Table 4: Internal Friction Angle for Coir Fibre (F) and Geosynthetics (G) as a modifying agent

%F/G	$(T1)_F$	$(T2)_F$	$(T3)_F$	$(AV)_F$	$(T1)_G$	$(T2)_G$	$(T3)_G$	$(AV)_G$
0	11.699	11.699	11.622	11.67	11.699	11.699	11.622	11.67
2	13.662	13.261	12.837	13.25	12.641	12.406	12.951	12.67
4	10.596	11.386	11.545	11.18	12.483	13.109	13.494	13.03
6	9.886	11.386	11.545	10.94	10.281	11.072	10.834	10.73
8	10.787	11.072	10.281	10.71	13.803	14.191	11.045	13.01
10	14.417	14.573	14.528	14.57	13.419	11.232	11.072	11.91

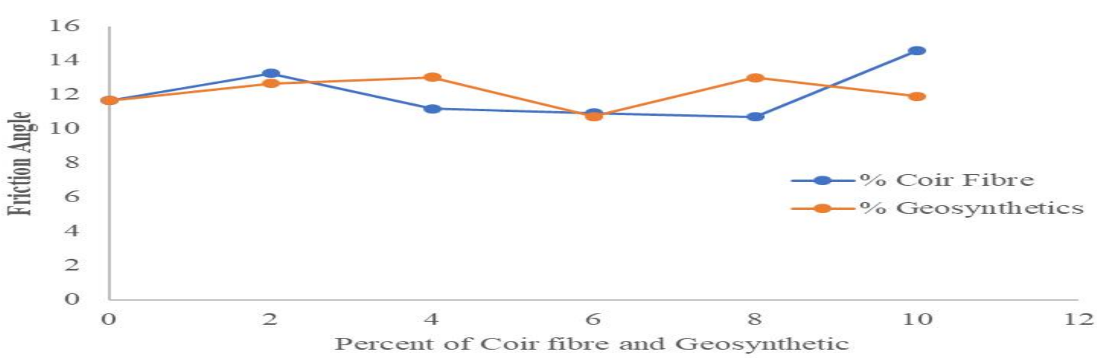

Fig 4: Combined graph of Friction Angle against the Percentage of Coir fibre and Geosynthetics

From Figure 4, the maximum friction angle occurred at 10% while the minimum friction angle occurred at 8%. This implies that at 10% coir fibre the shear resistance of the soil will be greater. While for the **Geosynthetics,** the maximum friction angle occurred at 4% while the minimum friction angle occurred at 6%. This implies that at 4% coir fibre the shear resistance of the soil will be greater.

3.4 Soil Bearing Capacity

Table 5 Soil Bearing Capacity for Coir Fibre (F) and Geosynthetics (G) as a modifying agent

%F/G	$(T1)_F$	$(T2)_F$	$(T3)_F$	$(AV)_F$	$(T1)_G$	$(T2)_G$	$(T3)_G$	$(AV)_G$
0	121	124	118	121	121	124	118	121
2	130	128	147	135	140	130	147	139
4	126	148	149	141	164	160	165	163
6	130	159	133	141	166	166	156	163
8	156	169	163	163	175	165	170	170
10	187	176	203	189	196	184	196	192

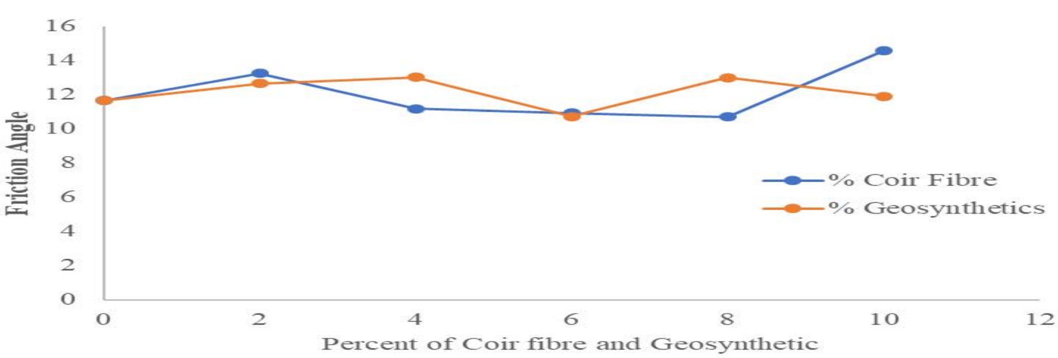

Fig 4: Combined graph of Friction Angle against the Percentage of Coir fibre and Geosynthetics

From Figure 4, the maximum friction angle occurred at 10% while the minimum friction angle occurred at 8%. This implies that at 10% coir fibre the shear resistance of the soil will be greater. While for the **Geosynthetics,** the maximum friction angle occurred at 4% while the minimum friction angle occurred at 6%. This implies that at 4% coir fibre the shear resistance of the soil will be greater.

3.4 Soil Bearing Capacity

Table 5 Soil Bearing Capacity for Coir Fibre (F) and Geosynthetics (G) as a modifying agent

%F/G	$(T1)_F$	$(T2)_F$	$(T3)_F$	$(AV)_F$	$(T1)_G$	$(T2)_G$	$(T3)_G$	$(AV)_G$
0	121	124	118	121	121	124	118	121
2	130	128	147	135	140	130	147	139
4	126	148	149	141	164	160	165	163
6	130	159	133	141	166	166	156	163
8	156	169	163	163	175	165	170	170
10	187	176	203	189	196	184	196	192

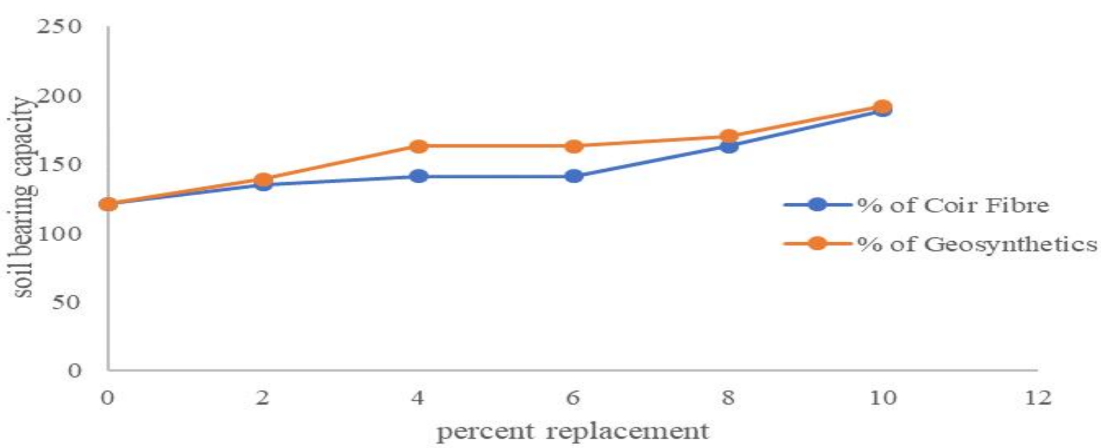

Fig 5: Combined graph of soil bearing capacity against the Percentage of Coir fibre and Geosynthetics

The result in Figure 5 shows that the addition of coir fibre increased the bearing capacity of the soil ranging from 121 to 189kpa for the coir fibre. While for Geosynthetics, the bearing capacity of the soil increased as the percentage of Geosynthetics increased. The value ranging from 121 to 192kN/m2. This is due to the particle sizes and the nature of Geosynthetics, which were shredded to smaller sizes of sieve size passing 600 micrometres. However, the results were not above 200kN/m2, so according to USCS, we can categorize the specimen as a loose gravel soil type.

4.0 Conclusion

The conclusion of this present research is based on the research aim and the general findings of this project. While the research aim was based on the strength capacity of clay soil modified with Geosynthetics and coconut coir fibre, the research findings were able to identify the performance of the soil when different percentages of Geosynthetics and coconut coir fibre were added to the soil. In simpler terms, the following conclusions are drawn from the studies:

i. The cohesion value for the triaxial test increased, with the highest cohesion occurring at 8% for coir fibre 39.33kpa and 6% for Geosynthetics 40.33kpa. The minimum cohesion occurred at 2% for both coir fibre and Geosynthetics, 27.67kpa.
ii. The internal friction angle increased with the maximum friction angle occurring at 10% for coir fibre, 14.57°, and at 4% Geosynthetics, 13.03°. The minimum friction angle occurred at 8% coir fibre, 10.71° and 6% of Geosynthetics 10. 73°. The safe bearing capacity increased as the percentage of both coir fibre and Geosynthetics increased.
iii. The maximum safe bearing capacity of the specimen occurred at 10% for both modifying agents.
iv. Treatment of the clay soil with coir fibre increased the CBR value from 3.53% for 0% unsoaked and 2.06% soaked to 11.35% for 10% unsoaked and 9.22% soaked, and also treatment with Geosynthetics increased the CBR value of the soil at 16.70% unsoaked condition and 11.21% for soaked condition. However, both CBR values did meet the minimum California Bearing Ratio of 6 required for subgrade. The unconfined compressive strength also improved the strength of the clay soil, and the maximum UCS value occurred at 10% for both additives

Declarations

Credit authorship contribution statement

M.O.P: J G.W; and S.B.A: Conceptualization. Wrote the original draft, Methodology, Validation, Resources, project administration, and review of the manuscript.

Declaration of competing interest

The authors declare no conflict of interest.

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Not applicable

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