Acta Technica Napocensis: Civil Engineering & Architecture
*Volume 62, No.1, (2019)*
Journal homepage: http://constructii.utcluj.ro/ActaCivilEng
ISSN 2344-4711, ISSN-L 1221-5848

# Stabilization of Lateritic Soil using Ground 'Pure water' Sachets

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*(Received 20 February 2019; Accepted 3 September 2019)*

## Abstract

*This study assesses the effects of stabilizing lateritic soil with ground 'pure water' sachets and compares the results with effects obtained by using cement on the same soil. The basic properties of the lateritic soil were first obtained through moisture content, specific gravity, particle size distribution and Atterberg limits tests after which the stabilizers were mixed with the lateritic soil at varying percentages of 2%,4%, 6%, 8%,and 10% by weight of the soil samples. Thereafter, compaction and unconfined compressive strength (UCS) tests were carried out on the sample mixes to determine the effects on the soil sample. The result of the compaction test showed that highest maximum dry densities obtained for the samples were 1.353 g/cm$^3$ at 10% cement addition and 1.337 g/cm$^3$ at 2% ground 'pure water' sachet addition. The UCS test showed that there was increase in unconfined compressive strength of the lateritic soil stabilized with ground pure water sachet from 442.87 KN/m$^2$ at 0% (untreated state) to 728.37 KN/m$^2$ at 4% by weight of dry soil; and with cement from 442.87 KN/m$^2$ at 0% (untreated state) to 1425.5 KN/m$^2$ at 4% by weight of dry soil.*

**Keywords:** Atterberg limits, stabilizers, compaction, compressive strength, dry densities

## 1. Introduction

In many African and Asian countries, it is virtually impossible to execute any construction work without using lateritic soils. Lateritic soil in its natural form is low in both strength and bearing capacity due to high volume of clay present in it. Its strength cannot be guaranteed under adverse moisture and stress conditions. They have a lower CBR and high plasticity index and the road structure can undergo severe degradation especially during wet seasons. The improvement achieved in the strength and durability of lateritic soil in recent times becomes imperative, this has geared up researchers toward using stabilizing materials that can be sourced locally at a very low cost [1].

Soil stabilization is the method of improving and enhancing the engineering properties of the soil such as the strength, bearing capacity, and durability of the soil, so as to increase its suitability for construction purposes. Different methods of soil stabilization have been performed over the years. Mechanical stabilization technique involves physically changing the properties of the soil in order to affects its gradation, solidity and other characteristics. Dynamic compaction and vibro

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compaction are examples of mechanical stabilization tecniques using vibration and deformation through kinetic force. Chemical stabilization technique is commonly used due to its low cost and convenience. It involves adding another material to the soil that will physically interact with it and change its properties.
Over the years, cement, bitumen and lime have been the main materials used for stabilizing soils. These materials have rapidly increased in price due to the sharp increase in the cost of energy and high demand for them. This has hitherto prevented third world countries like Nigeria in providing good roads for its citizens [2]. Portland cement, by the nature of its chemistry, produces large quantities of $CO_2$ for every ton of its final product which contributes to the melting of the ozone layer covering the earth surface [3]. Therefore, replacing proportions of the Portland cement in soil stabilization with solid particle polymeric waste such as pure water sachet will reduce the overall environmental impact of the stabilization process.

It was also reported that 30 % of the domestic waste in a typical Nigerian city comprises of the polyethylene and plastic products in very large quantities whose disposal has continued to constitute the great environmental pollution challenge in cities [4]. Pure water sachets constitute a major percentage of the polyethylene and plastic products. There has been improper disposal of pure water sachet waste which maybe due to the increase in population and producers of water sachets. Dumping of used pure water sachets on the roads, streets, and drainage channels ultimately leads to blockage of such channels and flooding of the environment during rainy season. In a bid to minimize these effects, burning of polyethylene waste materials has been adopted as a management strategy. This method in effect, constitutes a greater part of environmental pollution. This research study considers the beneficial reuse of this polymeric domestic waste product which might otherwise require costly transportation for disposal, and offers the potential for improving performance and lowering costs of constructing roads.

## 2. Background Literature

Lateritic soils are widespread in tropical areas and subtropical climates. They are the most highly weathered soils in the classification system. Lateritic soils are regarded as all products of tropical weathering with red, reddish brown or dark brown color, with or without nodules or concretions and generally (but not exclusively) found below hardened ferruginous crusts or hard pan [5]. The significant features of the lateritic soils are their unique color, poor fertility, and high clay content and lower cation exchange capacity. In addition, lateritic soils possess a great amount of iron and aluminum oxides.

A distinctive feature of lateritic soils is the higher proportion of sesquioxides of iron and/or aluminum it contains relative to the other chemical components. The amount of alumina or iron oxides is an important factor in differentiating aluminous and ferruginous varieties. The base (alkalis and alkaline earths) are almost absent in lateritic horizons, except in some ferruginous crusts developed in alluvium and some concretionary horizons in ferruginous tropical soils. Other common lateritic constituents are manganese, titanium, chromium and vanadium oxides.

Lateritic soils are valuable road pavement materials, widely used in the tropics as subbase, base material and for surface of gravel roads. They are also suitable for embankment construction.
Stabilization in a broad sense incorporates the various methods employed for modifying the properties of a soil to improve its engineering performance. Stabilization is used for a variety of engineering works, the most common application being in the construction of road and airfield pavements, where the main objective is to increase the strength or stability of soil and to reduce the construction cost by making best use of locally available materials. Soil stabilization is aimed at improving the soil density, increasing its cohesion and friction angle and reducing its plasticity

index.

Soil stabilized with cement is known as soil cement. The cementing action is believed to be the result of chemical reactions of cement with siliceous soil during hydration reaction. The important factors affecting the soil-cement are nature of soil content, conditions of mixing, compaction, curing and admixtures used. The basic function of cementation is to make the soil water-resistant by reducing swelling and increasing its compressive strength. Cement stabilization of soil is performed by mixing pulverized soil and cement with water and by compacting the mixture. Presence of water causes hydration of cement particles which grow into crystals that interlock with one another. It is not practical to apply cement stabilization of soil for which clay content percentage is not determined. Clay consists of the finest particles and can, in same way that cement does, coat the other particles in presence of water. When dried this kind of mixture becomes hard, but the problem occurs when the mixture is exposed to moisture again. Clay becomes plastic, making the mixture unstable and prone to breakage. Additional requirement for this method applicability is presence of no organic material.

The following reasons were deduced for finding alternatives to cement: high cost of production, high energy demand and emission of $CO_2$ which was responsible for global warming [6]. In third world countries, the most common and readily available material that can partially replace cement without economic implications are bio-based materials and agro-based wastes.The benefits of soil stabilization process include higher resistance values, reduction in soil’s plasticity, lowered permeability, reduction of pavement thickness, elimination of excavation, exportation of unsuitable material and importation of new materialsand enhanced compaction.

Several research works have been carried out on stabilizing lateritic soil using agro-based and bio-based waste materials such as banana leaves ash, groundnut husk ash, rice husk ash and wood ash, bamboo leaves ash among others. The first of these research studies to be considered is the work by [2] which assessed the impact of Cassava Peels Ash (CPA) on the stabilization of lateritic soil from which the following conclusions were reached namely that Cassava Peels Ash (CPA) improved the qualities of the soil samples by significantly reducing their plastic indices, increasing the maximum dry densities, increasing the California bearing ratio (CBR) which are indicative of soil improvement.

Secondly, the work by [7] investigated the potentials of rice husk ash (RHA) for lateritic soil stabilization. He concluded that the soil treated with RHA showed a general decrease in the MDD and increase in OMC with increase in the RHA content, there was also an improvement in the CBR (both soaked and unsoaked) as well as increase in the unconfined compressive strength (UCS)

Thirdly, [8] examined the geotechnical properties of lateritic soil stabilized with ashes of banana leaves. Based on their paper the following conclusions were drawn namely that banana leaves ash satisfactorily act as cheap stabilizing agents for subgrade purposes, optimum CBR results can be achieved by adding 4 % banana leaves ashes by weight of soil to the natural soil sample and the strength of lateritic soil stabilized with ashes of banana leaves increased.

Fourthly, [9] investigated the suitability of sugar cane straw ash stabilization of some lateritic soil samples for use as road construction material. Based on the tests he carried out the following conclusions were drawn namely that sugar cane straw ash is not a very good stabilizer but can still be used to improve the engineering properties of the lateritic soil and that the optimum percentage of the sugar cane straw ash by weight the soil for improvement in the strength characteristic of the soil samples is 4%.

Lastly, [10] studied the effects of bamboo leaf ash stabilization on lateritic soil. Based on their study, the following conclusions were drawn namely that bamboo leaf ash (BLA) improved the qualities of the soil samples by significantly reducing their plastic indices, reducing the OMCs of the samples while increasing the MDD values from those at the natural states.

### *2.1 Plastic Wastes*

Plastic wastes are wastes generated from any operation in which plastic substances are processed or used. Plastic is the general common term for a wide range of synthetic or semi-synthetic organic amorphous solid materials derived from oil and natural gas. The word 'Plastic' is derived from the Greek word ‘Plastikos’ meaning fit for molding and ‘Plastos’ meaning molded. Plastics are polymers which are substances made of many repeating units. The word polymer comes from two Greek words namely ‘poly’ meaning many, and ‘meros’ meaning parts or units.

The common plastics include polyester, polyethylene terephthalate, polyethylene, polyvinyl, polyvinylidene chloride, polypropylene, plastic polystyrene, high polystyrene polyamides, acrylonitrile butadiene styrene, polycarbonate and polycarbonate-acrylonitrile

### *2.2 Polyethylene*

Polyethylene is a thermoplastic polymer with variable crystalline structure and an extremely large range of applications depending on the particular type. It is one of the most widely produced plastics in the world. There is a vast array of applications for polyethylene in which certain types are more or less well suited. Generally speaking, High Density Polyethylene (HDPE) is much more crystalline, has a much higher density, and is often used in completely different circumstances than Low Density Polyethylene (LDPE). For example, LDPE is widely used in plastic packaging such as for grocery bags or plastic wrap. Polyethylene is commonly categorized into one of several major compounds of which the ones concerned in this research study include Low Density Polyethylene (LDPE) and High Density Polyethylene (HDPE).

### *2.3 Pure water sachet waste in Nigeria*

Every part of Nigeria is littered with sachet water nylon popularly called “pure water” sachet, the large volume of which in ordinary parlance, constitutes pollution [11]. This is as a result of millions of used sachets being thrown on daily basis onto the streets of virtually every city, town, and village in Nigeria.

About 70 percent of Nigerian adults drink at least a sachet of pure water per day resulting in about 50 to 60 million used water-sachets disposed daily across the country [12]. Presently the greatest environmental problem facing Nigeria, is municipal and public waste management. The cities are stinking from heavy unmanageable solid waste. Due to the present economic situation in Nigeria, water is packaged in low-density polyethylene (LDPE) sachet, this is popularly known as Pure Water. Pure Water Sachet serves as the cheapest packaging material. It has become popular in almost all the communities but unfortunately this has led to new source of solid waste since the LDPE has extremely low rate of degradation [13].

All plastics including pure water sachets are known to be non-biodegradable i.e. they cannot decompose like other organic waste, it is therefore not advisable for them to be landfilled or buried as they affect the soil structure, composition and the level of microbial activities in the soil. Scientifically, it is not advisable to incinerate (burn) plastic products, as this is known to generate air-borne cancerous toxics fumes such as dioxins and furans and a range of other dangerous air pollutants which causes variety of human health problems like; cancers, immune and reproductive system defects, spontaneous abortions, respiratory diseases, diabetes and hormone disruption etc. The burning of plastics and other waste materials is also known to cause damage to the ozone layer, which equally causes so many ill health and environmental degradation.

Utilizing/ recycling plastic waste provides a sustainable solution to the incessant blockage of drainages and other water channels with the attendant flooding which serves as breeding ground for mosquitoes and flies; diseases associated with these vectors will also reduce.
Reuse of these wastes also helps to achieve a clean and aesthetic environment, through reduced indiscriminate littering/dumping of the sachets, reduction in environmental pollution and degradation.

The use of waste plastic in construction of bituminous road was examined and it was deduced that the optimum content of waste plastic to be used is between the ranges of 5% to 10%, the bleeding problems are reduced in hot temperature region and sound pollution was reduced since plastics are sound absorbent [14].

The effects of 'pure water' sachets on the properties of conventional bitumen, suitability of discarded 'pure water' sachet as bitumen modifier and reduction of the environmental effects of 'pure water' sachet disposal were investigated [15]. The results showed that the penetration grades decreased as the 'pure water' sachet content increased in the blends while the values of the softening point increased with respect to increase in 'pure water' sachet. Also the dynamic viscosity of the modified bitumen increased with increasing 'pure water' sachet content.

## 3. Methodology and Materials

This project was carried out using the following materials: lateritic soil, ground 'pure water' sachets, cement and water. The lateritic soil sample was collected from a location in front of the Mandate lodge gate in Landmark University, Omu-Aran, Nigeria. Figure 1 shows a sample of the lateritic soil used.

Fig. 1: Lateritic soil sample

The pure water sachets were collected from trash cans within Landmark University campus. The sachets were originally used for packaging 'pure water' produced by the University. These were sorted out, cleaned with soapy water and later laid out in the open to dry. The dried pure water sachets were shredded into pieces and later ground into fine particles. Figure 2 shows the ground 'pure water' sachets.

Fig. 2: Ground 'pure water' sachets

Ordinary Portland cement which was used for this study was purchased from a cement seller close to Landmark University while potable water obtained on campus was used for preparation of the test specimens.

### *3.1 Laboratory Experiments*

Tests carried out included the natural moisture content, specific gravity, particle size distribution, Atterberg limits, compaction and unconfined compressive strength.

Natural moisture content test was conducted in accordance with the procedures stipulated in [16]. The amount of water present in the soil sample as a percentage of the mass of dry soil was determined. Moisture content is assumed to be the amount of water within the pore space between the soil grains which is removable by oven drying at a temperature not exceeding 110$^o$C. Equipments used are as follows: Drying oven with temperature of 105$^o$C to 110$^o$C, balance readable to 0.1g, metal container and desiccator.

Specific gravity is the ratio of the mass of unit volume of soil at a stated temperature to the mass of the same volume of gas-free distilled water at a stated temperature. This test was conducted in accordance with the procedures stipulated in [16]. to determine thephase relationship of air, wateer and solids of the soil sample. Equipments used include: Pycnometer, balance, vacuum pump, funnel and spoon.

Mechanical and hydrometer analyses were used to obtain the particle size distributions of the soil sample in accordance with standard procedures outlined in [16]. For the particle size analysis, fines were particles smaller than 0.075 mm (No. 200 sieve) while clay contents are the percentages of soil fraction smaller than 2μm.

The Atterberg limits determined included plastic limit, liquid limit and plasticity index. These tests were carried out in accordance with standard procedures outlined in [16].
Plastic Limit Test: The test was carried out to determine the lowest moisture content at which the soil is plastic. A sample of about 300g of lateritic gravel was passed through the 0.425mm sieve.
Liquid Limit: Liquid limit is the moisture content at which two sides of groove cut in the soil sample contained in the Casagrande cup apparatus would touch over a 13mm length after 25 blows.

Compaction test was conducted in accordance with procedures outlined in [16] so as to determine the dry density when the sample is compacted. The soil was air dried and pulverized sufficiently to run through BS sieve No. 4 (4.75 mm). Test specimens were prepared and compacted using British Standard Light (BSL) compactive effort.

The unconfined compressive strength test was carried out in accordance with procedures outlined in [16]. Unconfined compressive strength test was conducted to determine the shear strength parameters of the soil sample. This test is carried out in the triaxial apparatus on specimen in the form of cylinders of height approximately equal to twice the diameter.

## 4. Analysis and Discussion of Results

The natural moisture content, particle size distribution, specific gravity and the Atterberg limits tests were carried out to classify the lateritic soil while the compaction, and the California bearing ratio tests were carried out to assess the effects of ground purewater sachet and cement on the lateritic soil.

### *4.1 Natural Moisture Content*

The natural moisture content obtained for the lateritic soil used in this research was 4.2% which shows that the sample contains little amount of moisture. The results of the natural moisture content test are as presented in table 1.

Table 1: Natural Moisture Content Results

| S/N | Description (weight in grams) | Sample | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| 1 | Weight of can ($W_1$) | 22.50 | 23.50 | 21.00 |
| 2 | Weight of can + wet sample ($W_2$) | 116.50 | 102.50 | 123.00 |
| 3 | Weight of can + dry sample ($W_3$) | 113.00 | 99.00 | 119.00 |
| Calculations: | | | | |
| 1. | Weight of Dry Sample ($W_4$) = $W_3 - W_1$ | 90.50 | 75.50 | 98.00 |
| 2. | Weight of Moisture ($W_5$) = $W_2 - W_3$ | 2.50 | 3.50 | 4.00 |
| 3. | Moisture content ($M_C$)= ($W_5/W_4$) * 100% | 3.87 | 4.64 | 4.08 |
| 4. | Average Moisture Content | 4.20 | | |

### *4.2 Specific Gravity*

The specific gravity obtained for the lateritic soil was 2.58. The results are as presented in table 2.

Table 2: Specific gravity test results

| S/N | Description (weight in grams) | Sample | |
|---|---|---|---|
| | | 1 | 2 |
| 1. | Weight of empty pycnometer | 16.50 | 19.50 |
| 2. | Weight of empty pycnometer + dry soil | 36.50 | 39.50 |
| 3. | Weight of pycnometer + dry soil + water | 79.50 | 84.50 |
| 4. | Weight of pycnometer + dry soil + water | 67.00 | 72.50 |
| Calculations: | | | |
| 1. | Specific Gravity (GS) | 2.67 | 2.50 |
| 2. | Average Specific Gravity | 2.58 | |

### *4.3 Particle size distribution*

Table 3 shows a breakdown of the particle size distribution analysis of the lateritic soil. The weight of the soil sample used for the experiment was 1198g. The soil was classified as silty clay using the American Association of State Highway and Transportation Officials (AASHTO) Soil Classification System (i.e. the percentage of soil passing the 0.075mm sieve was above 35). Figure 3 shows the corresponding particle size distribution curve.

Table 3: Particle Size Distribution Analysis results

| S/N | Diameter (mm) | Weight of Soil Retained (g) | Percent Retained (%) | Percent Passing (%) |
|---|---|---|---|---|
| 1. | 4.75 | 0 | 0 | 100 |
| 2. | 2.0 | 48.00 | 4.0 | 96.0 |
| 3. | 1.18 | 122.00 | 10.2 | 85.8 |
| 4. | 0.6 | 116.00 | 7.2 | 78.6 |
| 5. | 0.425 | 116.50 | 9.7 | 68.8 |
| 6. | 0.3 | 110.50 | 9.2 | 59.6 |
| 7. | 0.15 | 133.50 | 11.2 | 48.4 |
| 8. | 0.075 | 105.50 | 8.8 | 39.6 |
| 9. | Pan | 444.00 | 37.1 | 0 |

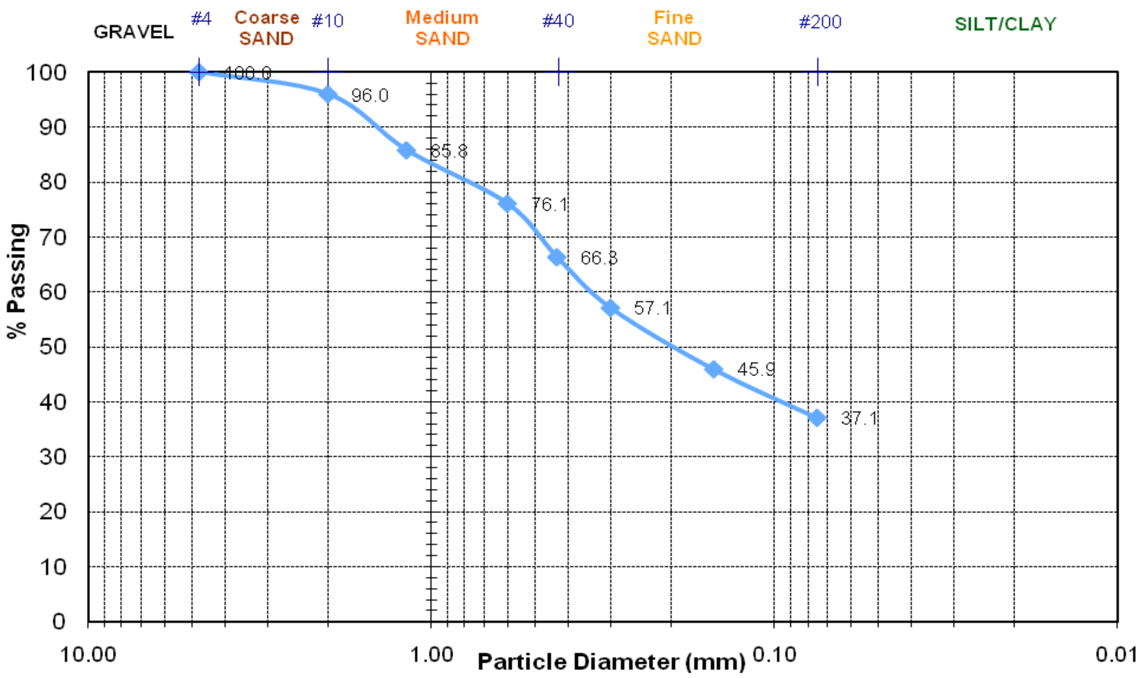


Figure 3: Particle size distribution curve

### *4.4 Atterberg limits*

The results of the Atterberg's limits test are summarized in tables 4 and 5. The liquid and plastic limits of the soil sample were 41.0% and 29.95% respectively, from which the plasticity index obtained was 11.05%. The group index (GI) was calculated as 5.86, and the soil was classified as A-7-5 using the American Association of State Highway and Transportation Officials (AASHTO)

Soil Classification System.

Table 4: Liquid Limit Analysis

| S/N | Description (weight in grams) | Sample | | | |
|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 |
| 1. | Weight of empty can + lid | 23.00 | 22.50 | 22.00 | 22.50 |
| 2. | Weight of can, lid, and moist soil | 34.00 | 30.00 | 29.50 | 31.00 |
| 3. | Weight of can, lid, and dry soil | 30.50 | 27.50 | 27.00 | 28.00 |
| 4. | Weight of soil solids | 7.50 | 5.00 | 5.00 | 5.50 |
| 5. | Weight of pore water | 3.50 | 2.50 | 2.50 | 3.00 |
| 6. | w = Water content, (%) | 46.67 | 50.00 | 50.00 | 54.55 |
| 7. | Number of Drops | 17 | 13 | 10 | 7 |
| 8. | Liquid Limit | 41.0 | | | |

Table 5: Plastic Limit Analysis

| S/N | Description (weight in grams) | Sample | |
|---|---|---|---|
| | | 1 | 2 |
| 1. | Weight of empty can + lid | 21.5 | 21.5 |
| 2. | Weight of can, lid, and moist soil | 30.0 | 30.5 |
| 3. | Weight of can, lid, and dry soil | 28.5 | 28 |
| 4. | Weight of soil solids | 7.0 | 6.50 |
| 5. | Weight of pore water | 1.5 | 2.50 |
| 6. | w = Water content, (%) | 21.43 | 38.46 |
| 7. | Average Water Content (Plastic Limit) | 29.95 | |

### *4.5 Compaction*

Compaction tests were carried out on the lateritic soil with and without the stabilizers. The MDD and OMC of the soil in its natural form before stabilization were 1.3035g/cm$^3$ and 16.67% respectively as shown in Figure 4. Each of the additives was added to the soil in varying percentages of 2%, 4%, 6%, 8% and 10% by weight of the soil.

Tables 6 and 7 show the optimum moisture contents and maximum dry densities for different percentages of cement and ground ‘pure water’ sachets added respectively. Figures 5 and 6 show the compaction curves for the lateritic soil with cement and ground ‘pure water’ sachets respectively.

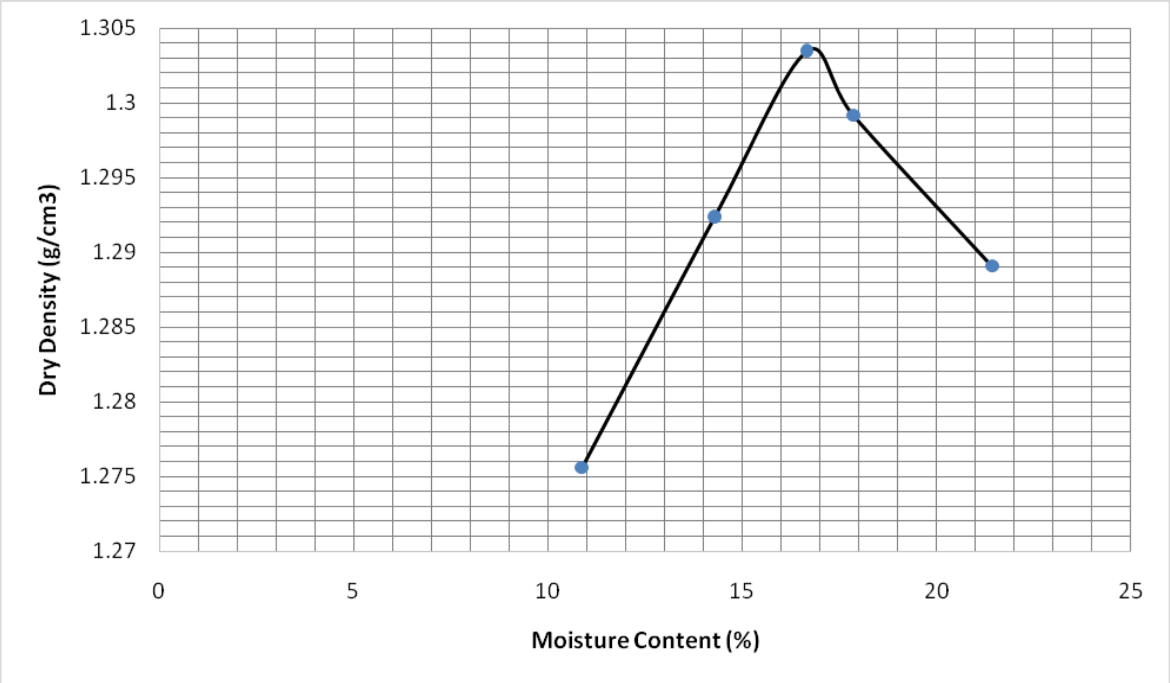


**Figure 4:** Compaction curve for control lateritic soil

Table 6: Compaction Test on Lateritic soil stabilized with cement

| S/N | Percentage Addition (%) | Maximum Dry Density (kg/m$^3$) | Optimum Moisture Content (%) |
|---|---|---|---|
| 1. | 0 | 1303 | 16.67 |
| 2. | 2 | 1339 | 10.45 |
| 3. | 4 | 1340 | 10.58 |
| 4. | 6 | 1344 | 12.96 |
| 5. | 8 | 1327 | 13.70 |
| 6. | 10 | 1353 | 14.02 |

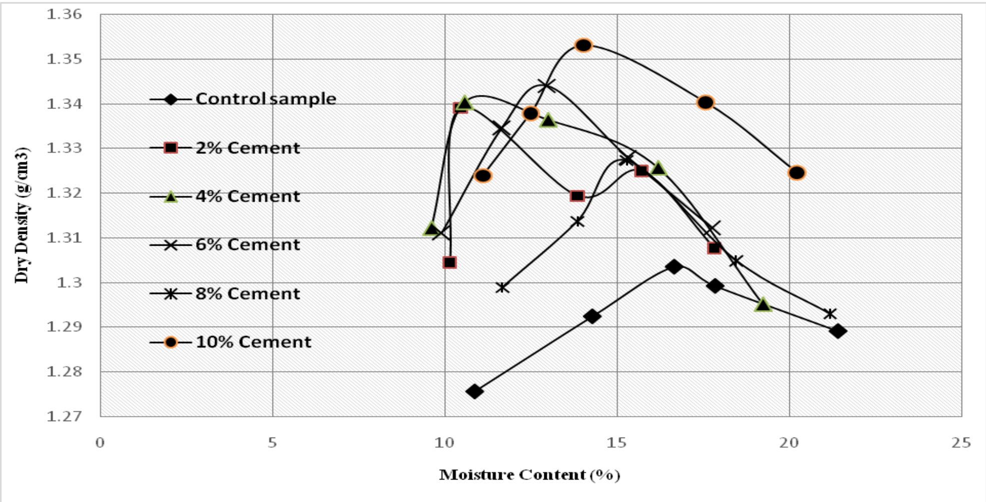


Figure 5: Compaction curve for lateritic soil stabilized with cement

Table 7: Compaction Test on Lateritic soil stabilized with ground pure water sachet

| S/N | Percentage Addition (%) | Maximum Dry Density (kg/m$^3$) | Optimum Moisture Content (%) |
|---|---|---|---|
| 1. | 0 | 1303 | 16.67 |
| 2. | 2 | 1337 | 12.12 |
| 3. | 4 | 1279 | 21.05 |
| 4. | 6 | 1259 | 21.43 |
| 5. | 8 | 1233 | 22.22 |
| 6. | 10 | 1207 | 22.92 |

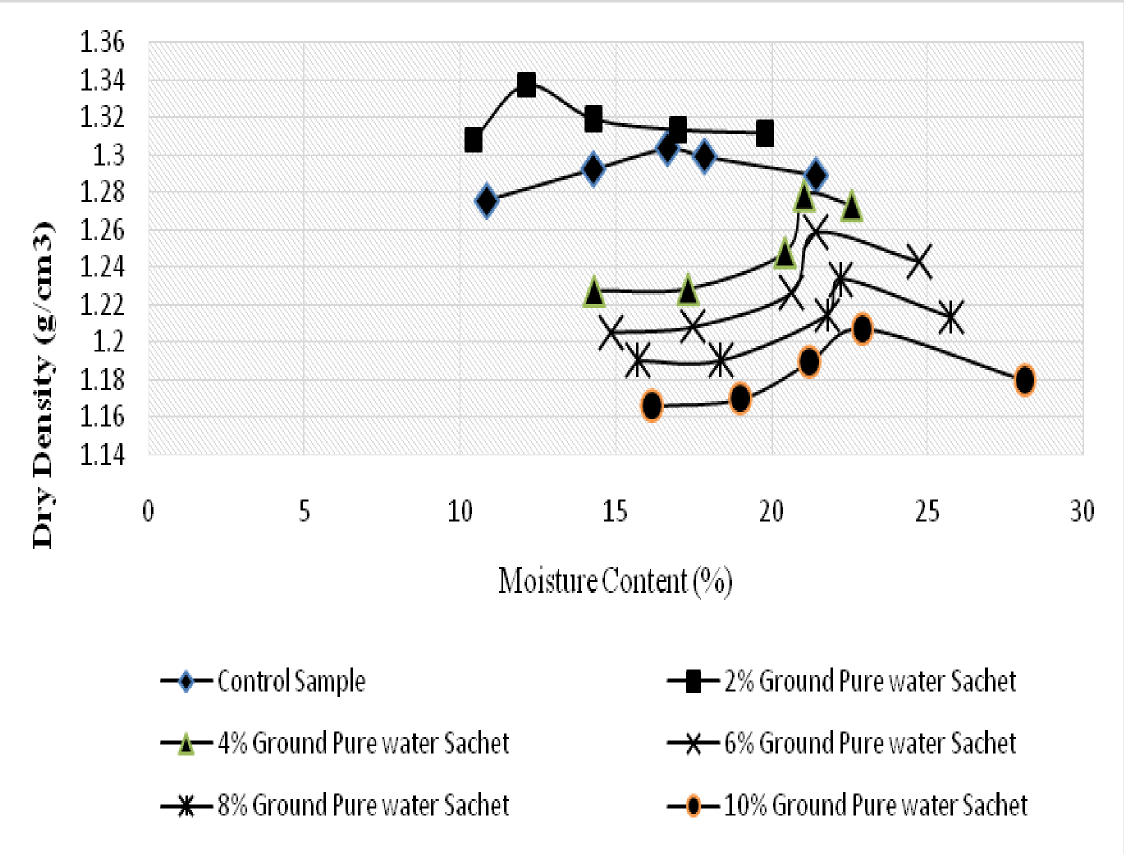


Figure 6: Compaction curve for lateritic soil stabilized with ground pure water sachet

### *4.6 Unconfined Compressive Strength (UCS)*

The results of the unconfined compressive strength test for lateritic soil with cement and ground 'pure water' sachets are presented in tables 8 and 9 respectively.

Table 8: UCS test results on Lateritic soil stabilized with cement

| S/N | Percentage Addition (%) | Unconfined Compressive Strength (KN/$m^2$) |
|---|---|---|
| 1. | 0 | 442.87 |
| 2. | 2 | 757.08 |
| 3. | 4 | 979.36 |
| 4. | 6 | 1209.57 |
| 5. | 8 | 1323.45 |
| 6. | 10 | 1425.50 |

Table 9: UCS test results on Lateritic soil stabilized with ground 'pure water' sachet

| S/N | Percentage Addition (%) | Unconfined Compressive Strength (KN/$m^2$) |
|---|---|---|
| 1. | 0 | 442.87 |
| 2. | 2 | 627.59 |
| 3. | 4 | 728.37 |
| 4. | 6 | 426.39 |
| 5. | 8 | 408.24 |
| 6. | 10 | 365.67 |

### *4.7 Discussion*

The compaction test results showed that the MDD of the control sample at 1303kg/$m^3$ (OMC = 16.67%) increased considerably on the addition of 2% ground 'pure water' sachets to 1337kg/$m^3$ (OMC = 12.12%). However, the values began to fall below that of the control thereafter upon increasing the ground 'pure water' sachets content. This indicates that the reaction of the soil with the ground 'pure water' sachets up to and at 2% favoured densification of the soil and thereafter did not. In the case of the cement, the MDDs showed appreciable increase throughout the process of its addition

The unconfined compressive strength values show that on adding the ground 'pure water' sachets to the lateritic soil, the UCS values increased up to 4% addition by weight of soil and thereafter began to reduce upon further addition up to 10%. However, the UCS values in the case of the lateritic soil stabilized with cement increased in values continuously up to 10% cement addition by weight of the soil.

## 5. Conclusion

This study has analyzed the geotechnical properties of lateritic soil stabilized with ground 'pure water' sachets in comparison with the lateritic soil stabilized with cement. Based on the results obtained from Atterberg limits test and the particle size distribution analysis, the natural lateritic soil was classified using AASHTO soil classification system as A-7-5 (silty-clay). This shows that the soil is not suitable as a subgrade material and cannot be used in road construction unless it is stabilized.

The compaction tests show that increased maximum dry densities are obtainable for the lateritic soil sample containing up to 10% cement by weight of soil, and lateritic soil sample containing up to 2% ground pure water sachet by weight of soil at OMCs of 14.02% and 12.12% respectively. This will ensure greater strength of the soil as well as ensure that it is less susceptible to changes in moisture content which may lead to swelling and shrinkage.

The UCS test results showed that there was increase in unconfined compressive strength of the lateritic soil stabilized with ground 'pure water' sachets from 442.87 $KN/m^2$ at 0% (untreated state) to 728.37$kN/m^2$ at 4% by weight of dry soil. Conversely, the UCS increased throughout up to 10% addition of cement.

Based on the a combined consideration of the compaction and unconfined compressive strength tests, it seems that the optimum value for addition of the ground 'pure water' sachets lies between 2% and 4% by weight of the soil.

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