EFFECT OF CASSAVA PEEL ASH ON THE GEOTECHNICAL PROPERTIES OF SOME SELECTED LATERITIC SOIL IN OSUN STATE

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CERTIFICATION

This is to certify that the work of this research was carried out by CHINEDU VICTOR MGBOH (TP12/13/H/1969), supervised by Dr. (Mrs.) A. L. Ayodele.

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DEDICATION

I would like to dedicate this research to God, Jesus, and the Virgin Mary who always show me the right path. To my parents and siblings, who have educated and supported me all through my existence. And to my love who makes everything possible and closes all the circles.

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LIST OF ABREVIATIONS AND SYMBOLS

AAS	Atomic Absorption Spectrometry
AASHTO	American Association of State Highway and Transport Officials
ASTM	American Society for Testing and Materials
BSI	British Standard International
CBR	California Bearing Ratio
CP	Cassava Peels
CPA	Cassava Peel Ash
GPS	Geographic Positioning System
LL	Liquid Limit
MDD	Maximum Dry Density
OMC	Optimum Moisture Content
PL	Plastic Limit
PI	Plasticity Index
UCS	Unconfined Compressive Strength
USCS	Unified Soil Classification System
SP	Standard Proctor
WA	West Africa
$\gamma_{d\ max}$	Maximum Dry Density
$w_{optimum}$	Optimum Moisture Content
q_u	Unconfined Compressive Strength
σ_1	Major Principal Stress
σ_3	Confining Pressure

ABSTRACT

This study is aimed at assessing the effect of Cassava Peels Ash (CPA) on the stabilization of lateritic soil with a view of improving its geotechnical properties.

Lateritic soil samples were collected from three different locations namely, Ife-East, Ayedaade and Olorunda Local Government Areas in Osun state, Nigeria, and were termed sample A, B and C, respectively. Cassava Peels were procured from a local cassava processing factory at Oke-Baale, Osogbo, Osun State. The chemical composition of the soil samples and the CPA, and the geotechnical properties such as grain size, liquid limit (LL), plastic limit (PL), optimum moisture content (OMC), maximum dry density (MDD), California bearing ratio (CBR) and unconfined compressive strength (UCS)of the soil samples were determined in their natural states. The Cassava Peels (CP) were dried and calcined at 700^{o}C for a period of 90 minutes in an electric furnace and the ash produced sieved through 425 µm sieve. The resulting CPA was added to the soil samples in incremental values of 2, 4, 6, and 8% by weight of the dry soil. Each soil sample was equally mixed with 4% lime by weight of the soil. The aforementioned geotechnical properties were determined for each Soil-CPA-Lime mixture. The data obtained from the tests were used to establish the optimum percentage of CPA.

The results showed that the soil samples as well as CPA contain between 34 and 42% silicon dioxide. The soil samples are acidic with pH ranging from 4.2 to 5.8. Whereas the CPA is basic (pH = 11.4). On addition of CPA and lime, the LL of sample A increased from 39.0 to 41.2%, sample B decreased from 46.2 to 36.7% and sample C decreased from 35.8 to 33.4% at the ratios of 2, 2 and 4% CPA, respectively. The PI for soil sample A decreased from 3.6 to 1.7%, sample B decreased from 16.1 to 2.3% and sample C decreased from 12.4 to 2.6% at the ratios of 2, 2 and 4% CPA, respectively. The MDD generally increased for all the soil samples as % CPA increased.

The MDD increased from 1558 to 2020 kg/m^3, 1850 to 2080 kg/m^3 and 1110 to 1940 kg/m^{3}at the ratios of 8, 4 and 4 % for samples A, B and C, respectively. The CBR for samples A, B and C increased from 18.0 to 25.0%, 21.0 to 27.0% and 17.0 to 18.0%, at the ratios of 8, 8 and 4% CPA, respectively. The result of the UCS tests generally increased as the % CPA increased. The highest values obtained were 400, 285, 215 kN/m^{2}at the ratios of 8, 8 and 4% CPA for samples A, B and C, respectively.

The study revealed that a combination of CPA and lime has the potential of improving the geotechnical properties of lateritic soil but no optimum percentage of CPA could be established for the studied soil samples.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

The need for construction of adequate transportation facilities and the maintenance of existing ones are enormously increasing with increase in population. Highway engineers most times are faced with the challenges of providing suitable earth (lateritic) materials for the construction of subgrade, subbase and sometimes base layers during road construction. Owning to this fact, continuous researches are being carried out by individual, firms and institutions on ways to improve the engineering properties of soils.

In some cases the available soils do not have adequate engineering properties to really bear the expected wheel load applied on them, thereby resulting in improvisations to be made so as to make these soils better and more adequate to resist the axle wheel load which will be applied on them after construction. The concept of making the soil better is called soil stabilization. Soil stabilization can be defined as any treatment (including chemical or mechanical) applied to a soil to improve its strength (geotechnical properties) and reduce its vulnerability to water (Murthy, 2007). If the treated soil is able to withstand the stresses imposed on it by traffic load under all weather conditions without deformation, then it is generally regarded as stable (O'Flaherty, 2002). Stabilisation can lead to the alteration of the physical (particle size distribution, arrangement of particles, parking of soil particles, amount of pore fluid) and chemical (soil mineralogy, chemical constitution, chemical bond between particles) properties of soil depending on the method of stabilisation used (Ayodele, 2014). The alteration of the physical and chemical properties of soil can result in change in some important geotechnical properties of soil such as increased shear strength, stiffness, load bearing capacity, volume stability and reduced lateral earth pressure, compressibility and permeability (Ayodele, 2014).

Based on the mechanism of altering soil properties for construction work, soil stabilisation can be broadly classified as mechanical and chemical stabilisations. Mechanical stabilization is the process of altering soil properties by changing the gradation through mixing with other soils, densifying the soils using compaction efforts, or undercutting the existing soils and replacing them with granular material. It is achieved by mixing or blending soils of two or more gradations materials to obtain a mixture meeting the required specifications. The soil blending may take place at the construction site, at a central plant, or a borrow area. The blended material is then spread and compacted to required densities by conventional means (Indiana Department of Transportation, 2008).

Chemical stabilization is the blending of the natural soil with chemical agents with cementitious properties. Stabilisation is achieved when the added chemicals react with the soil and form new and stable chemical compounds that bond or cement the soil particles together (Boardman, 1997). Thus, both the chemical and physical properties of the stabilized soil are changed. Several soil improving additives have been used to obtain different effects. The most commonly used additives are Portland cement, asphalt binders and lime. These chemical stabilizing additives can be mixed with any soil type to achieve stabilisation.

In order to make deficient soils useful and meet geotechnical engineering design requirements, researchers (Osinubi, 1997; Osinubi, 2000a, b; Moses, 2008; Alhassan and Mustapha, 2007; Medjo and Riskowiski, 2004; Osinubi and Eberemu, 2005; Osinubi and Stephen, 2006; Osinubi *et al*, 2007a,b; Osinubi *et al.*, 2008a,b; Osinubi and Eberemu, 2009; Osinubi *et al.*, 2009) have focused more on the use of potentially cost effective materials that are locally available from industrial and agricultural waste in order to improve the properties of deficient soils. The over dependence on industrially manufactured soil improving additives (cement, lime etc) have kept the cost of construction of stabilized road financially high. This hitherto have continued to deter the underdeveloped and poor nations of the world from providing accessible roads to meet the need of their rural dwellers who constitute large percentage of their population which are mostly rural farmers. Furthermore, the World Bank has been expending substantial amount of money on research aimed at harnessing industrial waste products for further usage (Oriola and Moses, 2010).

Thus, the possible use of agricultural waste such as Cassava Peel Ash (CPA) will considerably reduce the cost of construction and as well as reduce or eliminate the environmental hazards caused by such waste. Cassava is grown in all ecological zones of Nigeria, but predominantly in the middle belt and the southern parts of the country. Cassava is rich in mineral constituents such as; carbohydrates, starch, protein, fats, and fibre etc., which makes it a very good meal and highly reliable source of energy, sweeteners and industrial raw material. Cassava peel (CP) is a by-product of cassava processing, either for domestic consumption or industrial uses. Adesanya *et al.* (2008) reported that cassava peel constitutes between 20 - 35% of the weight of tuber, especially in the case of hand peeling. Based on 20% estimate, about 6.8 million tonnes of cassava peel is generated annually and 12 million tonnes is expected to be produced in the year 2020. Indiscriminate disposal of cassava peels due to gross underutilization as well as lack of appropriate technology to recycle them is a major challenge, which results in environmental problem. Thus, the need for alternative