

**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.

OBAFEMI AWOLOWO UNIVERSITY

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TABLE OF CONTENTS

TITLE PAGE	i
CERTIFICATION	ii
DEDICATION	iii
ACKNOWLEDGEMENTS	iv
TABLE OF CONTENTS	v
LIST OF TABLES	viii
LIST OF FIGURES	ix
LIST OF ABBREVIATIONS	x
ABSTRACT	xi
CHAPTER ONE: INTRODUCTION	1
1.1 General Background	1
1.2 Aim of the Research	4
1.3 Objectives and Scope of the Research	4
1.4 Justification for the Study	5
CHAPTER TWO: LITERATURE REVIEW	6
2.1 Soil Stabilization	6
2.2 Mechanical Stabilization	7
2.3 Chemical Stabilization	9
2.3.1 Lime stabilization	12
2.3.2 Cement stabilization	18
2.3.3 Bitumen and tar	21
2.4 Pozzolan	24
2.4.1 Fly ash	24
2.5 Cassava Peel Ash	25

2.6	Laterite and Lateritic Soils	28
2.6.1	Laterite	28
2.6.2	Lateritic soil	29
2.6.3	Origin of laterites	30
2.6.4	Structural characteristics of lateritic soils	30
2.7	Past Works on Chemical Soil Stabilization	31

CHAPTER THREE: MATERIALS AND METHODS 35

3.1	Overview	35
3.2	Materials	35
3.2.1	Soil sampling	35
3.2.2	Collection of cassava peels	36
3.3	Equipment for Laboratory Experiment	36
3.4	Methods	36
3.4.1	Preliminary analysis of soil samples in their natural state	37
3.4.2	Preparation of CPA	40
3.4.3	Determination of physicochemical and strength properties of the lateritic soils in their natural state	40
3.4.4	Mixing of soil with different proportions of cassava peel ash	42
3.4.5	Determination of geotechnical properties of the lateritic soils mixed with CPA	42
3.4.6	Determination of the optimum CPA required for soil stabilization	43
3.4.7	Statistical analysis	43

CHAPTER FOUR: RESULTS AND DISCUSSION 45

4.1	General	45
4.2	Results of Preliminary Analysis of the Soil Samples in their Natural States	45

4.2.1	Natural moisture content of the soil samples	45
4.2.2	Specific gravity of the soil samples	45
4.2.3	Atterberg Limit Results of soil in their natural states.	45
4.2.4	Soil classification	48
4.2.5	Compaction properties of Soil Samples in their natural states	48
4.2.6	California Bearing Ratio (CBR) of soil samples in their natural states	51
4.2.7	Unconfined Compressive Strength of the samples in their natural states	51
4.3	Physiochemical Properties of the Soil Samples and CPA	51
4.4	Atterberg Limits of Stabilized Soils Samples	53
4.5	Compaction Results of Stabilized Soils	63
4.6	California Bearing Ratio of stabilized soils	68
4.7	Unconfined Compressive Strength Results of treated soils	72
4.8	Optimum Percentage of CPA for stabilization	78
CHAPTER FIVE: CONCLUSION AND RECOMMENDATION		79
5.1	Conclusion	79
5.2	Recommendation	80
REFERENCES		81
APPENDIX A	RESULTS OF HYDROMETER TESTS	90
APPENDIX B	ATTERBERG LIMIT TESTS	93
APPENDIX C	COMPACTION TEST	103
APPENDIX D	CALIFORNIA BEARING RATIO TEST	115
APPENDIX E	UNCONFINED COMPRESSIVE STRENGTH TEST	128

LIST OF TABLES

Table 2.1:	Mechanisms and applicability of various stabilizing agents	10
Table 2.2:	Effects of soil mineralogy on stabilization response	11
Table 2.3:	Typical cement requirements for various soil types	19
Table 2.4:	Chemical composition of CPA and laterite	27
Table 2.5:	Some common properties of laterites	32
Table 4.1:	Description of soil samples from selected locations.	46
Table 4.2:	Summary of the preliminary analysis of soil samples	47
Table 4.3:	Chemical composition of CPA and soil samples	54
Table 4.4:	Atterbergs Limits of stabilized soil samples	55
Table 4.5:	Effect of stabilization and sample location on LL of soil	60
Table 4.6:	Effect of stabilization and sample location on PL of soil	61
Table 4.7:	Effect of stabilization and sample location on PI of soil	62
Table 4.8:	Summary of compaction results	64
Table 4.9:	Effect of stabilization and sample location on OMC of soil	69
Table 4.10:	Effect of stabilization and sample location on MDD of soil	70
Table 4.11:	Summary of CBR results	71
Table 4.12:	Effect of stabilization and sample location on CBR of soil	73
Table 4.13:	Summary of the results for UCS Tests	75
Table 4.14:	Effect of stabilization and sample location on UCS of soil	77

LIST OF FIGURES

Figure 2.1: Influence of the addition of lime on the plastic limit, liquid limit and plasticity of clay of high plasticity	14
Figure 2.2: Influence of the addition of lime on the compaction curves of clay soil	15
Figure 2.3: Unconfined Compressive strength of tar-stabilized clayey sand	23
Figure 4.1: Particle Size Distribution curve for the three soil samples	49
Figure 4.2: Liquid Limit chart for the soil samples	50
Figure 4.3: Compaction characteristics of soil samples in their natural states	52
Figure 4.4: Variation of Atterberg limits with increasing CPA and lime for sample A	57
Figure 4.5: Variation of Atterberg limits with increasing CPA and lime for sample B	58
Figure 4.6: Variation of Atterberg's limit with increasing CPA and lime for sample C	59
Figure 4.7: Variation of OMC with increasing CPA and lime mix for the three soil samples	66
Figure 4.8: Variation of MDD with increasing CPA and lime mix for the three soil samples	67
Figure 4.9: Variation of CBR with increasing stabilization mix for the three soil samples	74
Figure 4.10: Variation of UCS with increasing stabilization mix for the three soil samples	76

LIST OF ABBREVIATIONS 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°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/m³, 1850 to 2080 kg/m³ and 1110 to 1940 kg/m³ 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/m² 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. Owing 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