wjert, 2021, Vol. 8, Issue 11, 29-40. *Original Article* **ISSN 2454-695X**

World Journal of Engineering Research and Technology

WJERT

www.wjert.org

SJIF Impact Factor: 5.924

CHARACTERISTICS OF THE MANGROVE SOIL OF THE GUINEAN COASTAL ZONE, IN THE ROUGH STATE AND IN THE STABILIZED STATE

Abdoulaye CISSE[1], Mamadouba CONTE[2], Alama CAMARA[3] and Yacouba CAMARA[4]*

[1]Institut Supérieur Agronomique et Vétérinaire, Valéry Giscard d'Estaing, Département Génie Rural, BP 131, Faranah, Guinée.

[2]Institut Supérieur Agronomique et Vétérinaire, Valéry Giscard d'Estaing, Département Génie Rural, BP 131, Faranah, Guinée.

[3]Centre de Recherche Scientifique de Conakry-Rogbané, Département : Matériau de Construction et Produits Finis, BP 1615, Ratoma, Conakry, Guinée.

[4*]Institut Supérieur de Technologie de Mamou, Département : Energétique, BP 63, Mamou, Guinée.

Article Received on 05/09/2022 **Article Revised on 26/09/2022** **Article Accepted on 17/10/2022**

***Corresponding Author**
Yacouba CAMARA
Institut Supérieur de Technologie de Mamou, Département : Energétique, BP 63, Mamou, Guinée.

ABSTRACT

Mangrove soil is a material rarely used in the Republic of Guinea. It is important to know the characteristics of this material in order to use it in construction. The objective of this work is to know the chemical, physical and mechanical characteristics of mangrove soil, stabilized or not for its use in construction. To achieve this objective, tests and analyzes were carried out both on the material in its raw state and in its stabilized state. The chemical analysis has shown that the Guinean mangrove soil contains in its raw state (unstabilized) a significant quantity of humus, approximately 49.97 mg/l, but the addition of hydraulic binder leads to a reduction in this content. Particle size analysis gave us 55% clay, 44.5% sand and 0.50% gravel. This means that the mangrove soil is very clayey, which does not favor its use in the construction of buildings without stabilization. For a plasticity index Ip equal to 31.21 in the raw state, stabilization with hydraulic lime caused the reduction of this parameter, and the increase of the consistency index. The results of this work show that Guinean mangrove soil can be used in certain areas of construction.

KEYWORDS: Optimization, characteristics, land, stabilization, construction, coastal zone.

1. INTRODUCTION

The coastal zone is the interface between the mainland and the sea. It is the portion of the coast, the littoral, constituted by the benthic ecosystems between the line of terrestrial vegetation (upper limit) and the line of low tide (lower limit).

Often, the land sector and the near-shore marine sector fall under complex and different jurisdictions. It is estimated that 60% of the world's population lives on or near the coast, where the pressures of economic activities on the coastal environment are particularly high.

According to the Ramsar definition of wetlands, a very large portion of the coastal zone falls within the scope of this Convention, so that, taking into account their commitments, governments must contribute in a significant way to good integrated management. coastal areas.

The desire for regional planning leads to the development of infrastructures (housing, roads, motorways, railways or industrial platforms) whose locations and constructions require knowledge of the various materials used in the construction of walls, embankments, subgrade and base layers.

Given the nature of the terrain encountered in Guinea, the infrastructures are made with materials, requiring treatment to meet the mechanical and rheological characteristics required.

For economic reasons, in Guinea, the use of local materials is a necessity because imported materials are more expensive.

The various soil treatment techniques still encounter failures. These failures are manifested by insufficient mechanical and rheological characteristics or by shrinkage and swelling which destroy the material, thus causing serious economic consequences.

The stabilization of mangrove soil, a clay material with a high organic matter content, with lime, and particularly with hydraulic lime, would be a good solution for its use in construction.

2. MATERIALS AND METHOD

2.1.Materials

The earth used in this study, the mangrove earth comes from the quarry of the port of Sonfonia in Conakry in the coastal region of Guinea.

Hydraulic lime from Amarya limestone, Kindia Prefecture was used for stabilization.

For particle size analysis, we used square mesh sieves (12.5mm; 8.0mm; 5.0mm; 2.5mm; 1.25mm; 0.500mm; 0.250mm; 0.125mm and 0.080mm).

To determine the optimum amount of compaction water, the normal Proctor mold was used.

For the Atterberg limits, the following materials were used:

- ✓ The cassagrande device with its smooth cup;
- ✓ The tool to be assembled;
- ✓ The Pitcher for dosing the dampening water;
- ✓ The 0.400mm square mesh sieve for the sample that served as the Atterberg limit
- ✓ The laboratory mortar and pestle to pulverize the sample;
- ✓ (Five) desiccators for sample preservation;
- ✓ The electric oven;
- ✓ The analytical balance with an accuracy of 0.001g;
- ✓ The marble for mixing the sample;
- ✓ The trowel;
- ✓ And the test sheets for the Atterberg limit.

For chemical analyzes the electric muffle furnace; a Reagent Kit; a protocol document; small pliers; gloves; glasses; lab coats and LABOLAB software.

2.2- Method

The soil sampled is first carefully packaged and sent to the CERESCOR laboratory and to the Central Building and Public Works Laboratory (LBTP) for the various analyzes

The following activities are carried out:

126 specimens of stabilized earth are made to assess the compressive strength of the material.

The Atterberg limits are determined to assess the rheological characteristics of the stabilized raw earth.

After determining its chemical composition, the sample of mangrove soil is treated with lime.

- Chemical analyzes are done to determine the dosage of the following elements:

Nitrate (NO_3^-) ; nitrite (NO_2^-) ; total iron (Fe^{2+}) ; sulfate (SO_4^{2-}) ; phosphate (PO_4^{3-}) ; calcium (Ca); chloride (Cl^-) and humus.

- The granulometry of the earth is made in two stages
- first by wet sieving to determine the sand content. This consisted in successively washing the earth material (mangrove) in a sieve with meshes: 5 and 0.08mm until clear water was obtained on the sand refusal on each sieve.
- then by Routovski test in order to determine the clay content. This method is based on the swelling properties of the clay part of the earth in contact with water. According to this method, the clay in contact with water swells and the level of swelling is related to the clay fraction content of the earth.

The clay content of the soil is determined by the following relationship:

$$X = 22{,}7kv \quad (1)$$

Where : $kv = \frac{V_2 - V_1}{V_1}$

With :

$V_1 = 10ml$ is the take of the dried sample. This quantity is compacted in a graduated tube of $100ml$.

V_2 is the volume of the same catch after sedimentation for 24 hours in the same graduated tube which has previously been filled with water.

- To determine the Atterberg limits of mangrove land with or without stabilizer, the following procedure was observed:

the plastic limit (Wp) of the sample with or without stabilizer representing the water content from which the material ceases to be considered in a dry state; the liquid limit (W_l) of the sample with or without stabilizer representing the water content from which the material begins to flow, are determined with the Cassagrande apparatus.

The plasticity index (Ip) is calculated by the following relationship:

$$I_P = W_l - Wp \quad (2)$$

The consistency index (Ic) is determined by the relationship (3):

$$I_C = (W_L - W_{nat}) / I_P \quad (3)$$

This relationship is valid for soil samples whose particles are very fine, such is the case of Guinean mangrove soil.

3. RESULTS AND DISCUSSION

The results of this study are shown in the tables and figures below:

3.1. Results of chemical analysis on the mangrove sample before stabilization

The results of the chemical analyzes of the different samples of mangrove soil before stabilization are recorded in Tables 1 and 2.

Table 1: Dosage of chemical elements in mangrove soil before stabilization (natural state).

Parameters	TDS (mg/l)	Nitrate (mg/l) NO_3^-	Nitrite (mg/l) NO_2^-	Total iron (mg/l) Fe^{2+}	Sulfate (mg/l) SO_4^{2-}	Phosphate (mg/l) PO_4^{3-}	Calcium (mg/l) Ca	Chloride (mg/l) Cl^-	Magnesia (mg/l) MgO	Quicklime (mg/l) CaO	Humus (mg/l)
Value	0,85	6,94	7,56	0,92	0,34	7,85	8,16	6,56	9,87	0,98	49,97

Legend : TDS : Salinity rate,

In this table, it appears that the amount of humus is too high, which already indicates that mangrove soil is not a good sustainable material.

Table 2: Mangrove sedimentometry before stabilization.

Date	TIMES		Time spent reading	Temperature	Correction. depending on the temperature	Hydrometer reading	Corrected Reading	Percentage of passers-by	Reading corrected for meniscus	Table R function	$\frac{L}{T}$	Correction. Function of Ys and °C	$\sqrt{\frac{L}{T}}$	$D = K\sqrt{\frac{L}{T}}$ (mm)
	H	Min	t (Min)	°C	Tc	Ra	Rc	%	R	L		K		
13/10/2021	10	03	1	29	3,8	25	21,75	57,64	26	12,1	12,10	0,0123	3,48	**0,043**
13/10/2021	10	09	4	29	3,05	13	9,75	25,84	14	14,3	3,58	0,0123	1,89	**0,023**
13/10/2021	10	22	19	29	3,05	10	6,75	17,89	11	14,8	0,78	0,0123	0,88	**0,011**
13/10/2021	11	03	60	29	3,05	8	4,75	12,59	9	15,1	0,25	0,0123	0,50	**0,006**
13/10/2021	13	02	180	29	3,05	7	3,75	9,94	8	15,4	0,09	0,0123	0,29	**0,004**
14/10/2021	10	03	1440	29	3,05	5	1,75	4,64	6	14,8	0,01	0,0123	0,10	**0,001**

This table tells us that this mangrove soil contains 55% clay. This means that it is of the clay type, unsuitable for the foundation of constructions and difficult to stabilize.

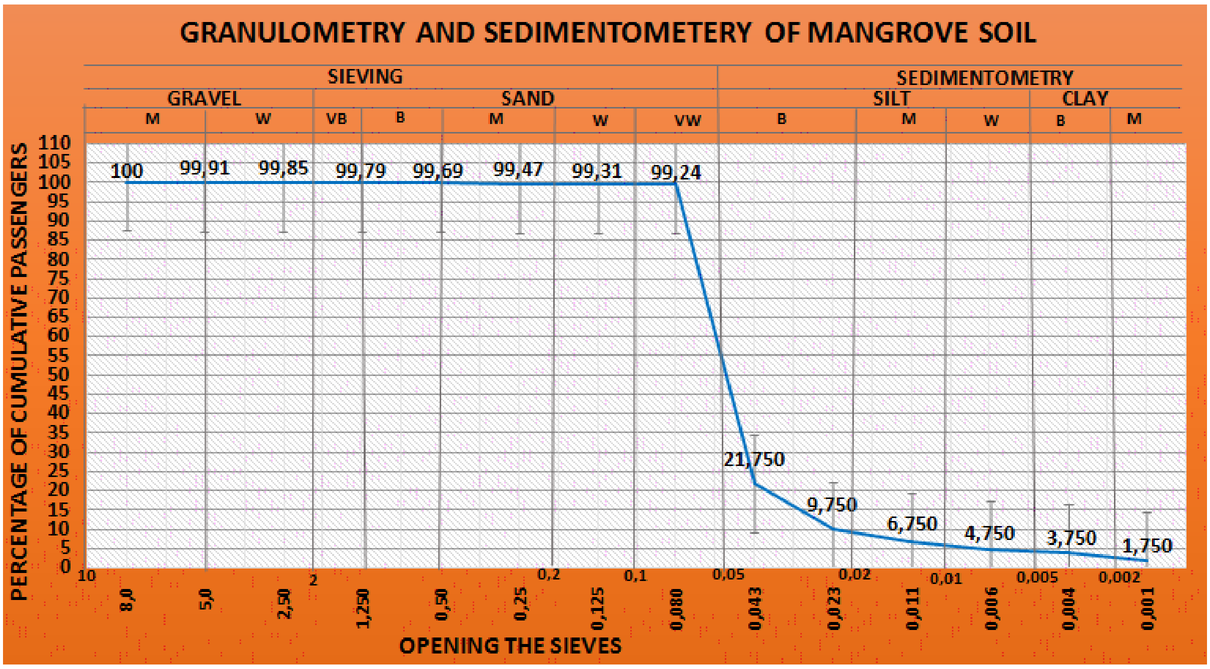

Figure 1: Granulometry by sieving and sedimentometry of mangrove soil.

Legend : M : Medium; F : Weak; TG : Very large; G : Large ; TF : Very Weak

On this figure, it appears that the soil of the mangrove contains 55% clay, 44.50% sand and 0.50% gravel, which specifies the clayey character of this soil.

Atterberg limit of the mangrove land

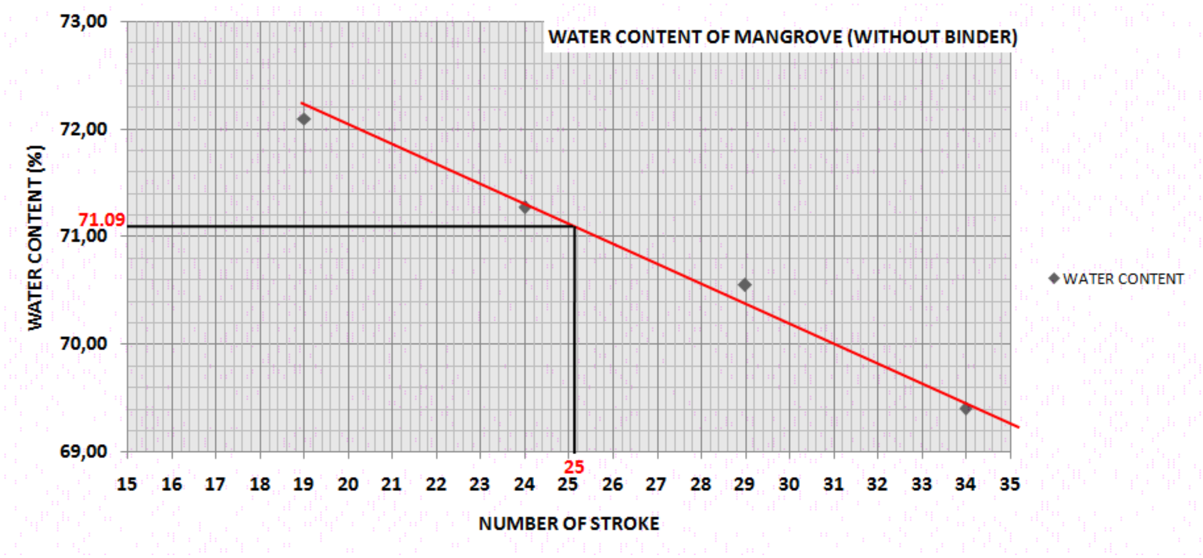

Figure 2: Water content of mangrove soil in its raw state (without stabilization).

This test made it possible to determine the liquid limit (LL = 70.73), the plastic limit (Lp = 39.60), the plasticity index (Ip = 31.13) and the consistency index of the raw sample (Ic = 1.71).[3]

With regard to the raw sample (without stabilizer) the graph teaches us that the water content at 25 strokes of the Cassagrande apparatus is 71.09%, which means that the sample requires a large quantity of water, which does not provide a good base for the construction works or protect an embankment.[4]

3.2. Results of chemical analysis on the mangrove sample after stabilization

The results of the chemical analyzes of the different samples of mangrove soil after stabilization are recorded in Tables 3 and 4.

Table 3: Dosage of the chemical elements of the mangrove after stabilization with lime, cement and bastard binder (lime+cement).

Parameters / Dosages	TDS (mg/l)	Nitrate (mg/l) NO_3^-	Nitrite (mg/l) NO_2^-	Total iron (mg/l) Fe^{2+}	Sulfate (mg/l) SO_4^{2-}	Phosphate (mg/l) PO_4^{3-}	Calcium (mg/l) Ca	Chloride (mg/l) Cl^-	Magnesia (mg/l) MgO	Quicklime (mg/l) CaO	Humus (mg/l)
With 5% de lime	1,73	6,85	6,23	2,14	5,62	6,26	10,71	5,32	10,2	13,21	31,73
With 8% de lime	1,91	7,01	7,91	3,16	5,71	7,61	11,07	7,61	11,31	14,32	**22,38**
With 5% de cement	1,61	6,33	6,17	2,05	4,21	6,06	9,31	4,13	8,31	10,34	41,48
With 8% de cement	1,70	6,71	6,33	2,83	5,02	6,79	10,01	4,91	9,07	11,11	35,52
With 5% de lime + 3% de cement	**2,71**	**7,17**	**8,93**	**3,26**	**7,01**	**9,83**	**18,90**	**5,92**	**7,17**	**27,21**	**1,89**
With 3% de lime + 5% de cement	**2,17**	**8,05**	**8,31**	**4,43**	**6,41**	**9,51**	**17,85**	**7,93**	**10,20**	**23,04**	**2,10**

These data indicate that stabilization with hydraulic lime has a positive effect on mangrove soil for its use in construction. With the different dosages of binders, it is found that the quantity of humus decreases. In this table, we note that the stabilization with hydraulic lime is better than that with cement and, even better is the stabilization with the bastard binder (lime + cement).

Sedimentometric analysis of stabilized earth

Table 4: Mangrove sedimentometry after stabilization.

Date	TIMES		Time spent reading	Temperature	. depending on the temperatu	Hydrometer reading	Corrected Reading	Percentage of passers-by	Reading corrected for .	Table R function	$\frac{L}{T}$	Correction. Function of ϒs and °C	$\sqrt{\frac{L}{T}}$	$D = K\sqrt{\frac{L}{T}}$ (mm)
	H	Mn	t	°C	Tc	Ra	Rc	%	R	L		K		

			(Mn)											
13/10/2021	10	03	1	30	3,8	25	21,75	59,63	26	12,1	12,10	0,0123	3,48	**0,043**
13/10/2021	10	09	4	30	3,8	13	9,75	27,83	14	14,3	3,58	0,0123	1,89	**0,023**
13/10/2021	10	22	19	30	3,8	10	6,75	19,88	11	14,8	0,78	0,0123	0,88	**0,011**
13/10/2021	11	03	60	30	3,8	8	4,75	14,58	9	15,1	0,25	0,0123	0,50	**0,006**
13/10/2021	13	02	180	30	3,8	7	3,75	11,93	8	15,4	0,09	0,0123	0,29	**0,004**
14/10/2021	10	03	1440	30	3,8	5	1,75	6,63	6	14,8	0,01	0,0123	0,10	**0,001**

This table provides information on the 35% clay content of the mangrove soil. This means that this soil is still clay type, however, stabilization has reduced its clay content. H. JOSSEAUME came to the same conclusion in 1994.

Atterberg limit of the mangrove land:

The liquid limit, the plastic limit, the plasticity index and the consistency index of the raw sample and the stabilized sample at different dosages of lime, cement and bastard binder (lime+cement) have been determined.

To lower the water requirement of the mangrove soil, we stabilized with different dosages of hydraulic lime, cement and bastard binder (lime+cement).

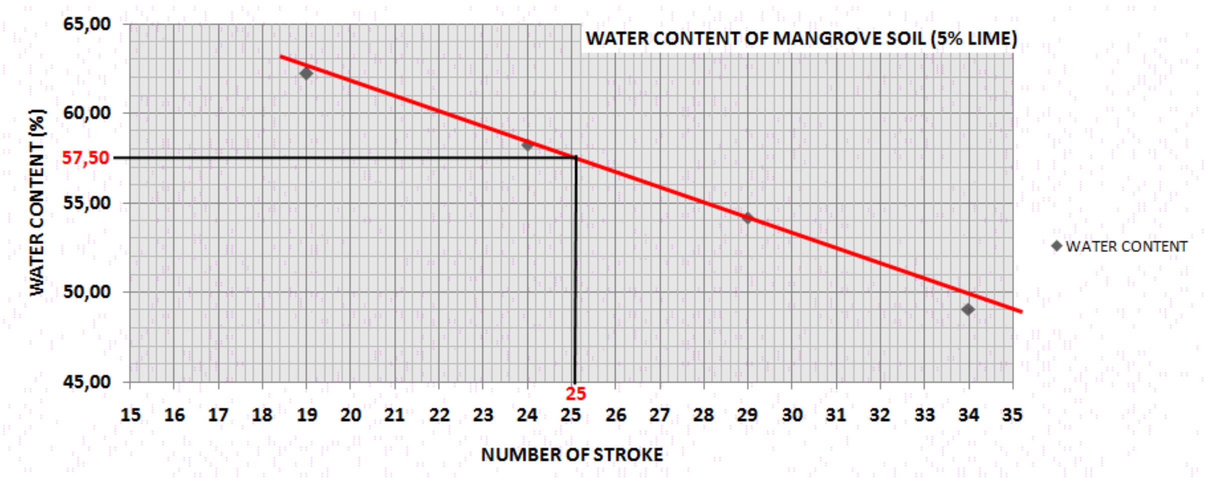

Figure 3: Water content of mangrove soil in its stabilized state (5% hydraulic lime).

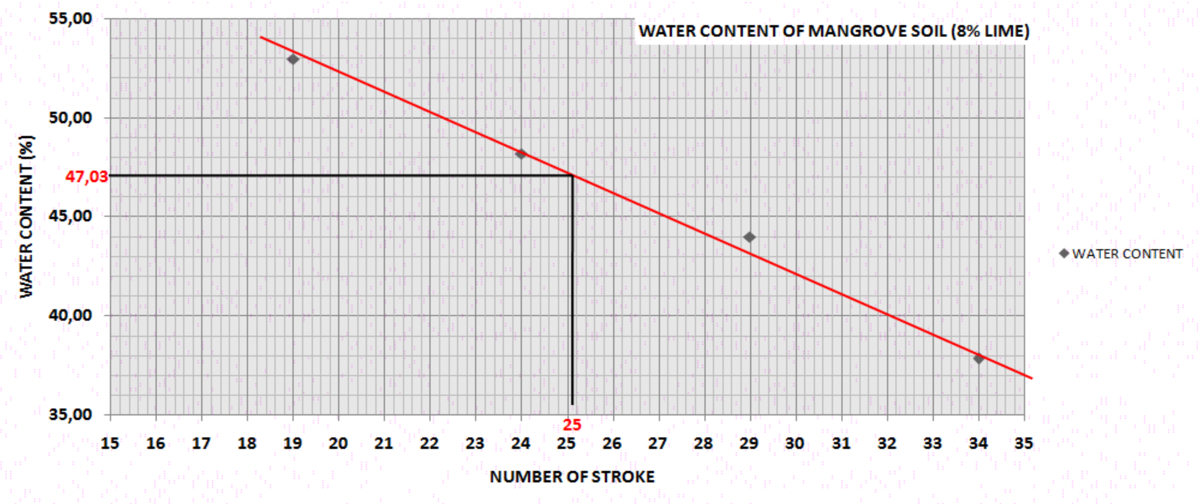

Figure 4: Water content of mangrove soil in its stabilized state (8% hydraulic lime).

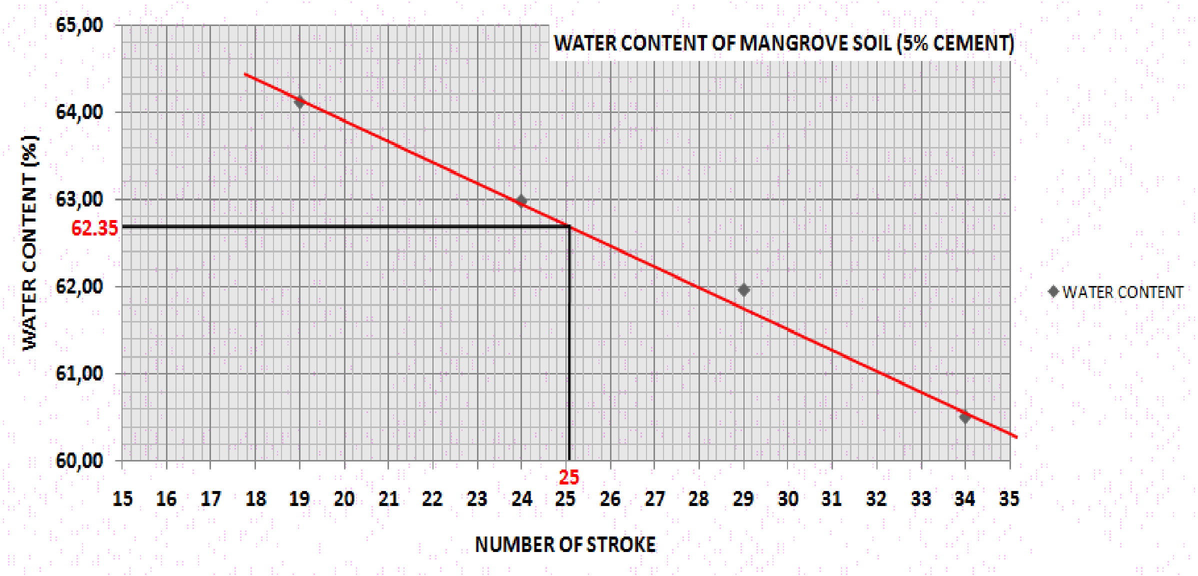

Figure 5: Water content of mangrove soil in its stabilized state (5% cement)

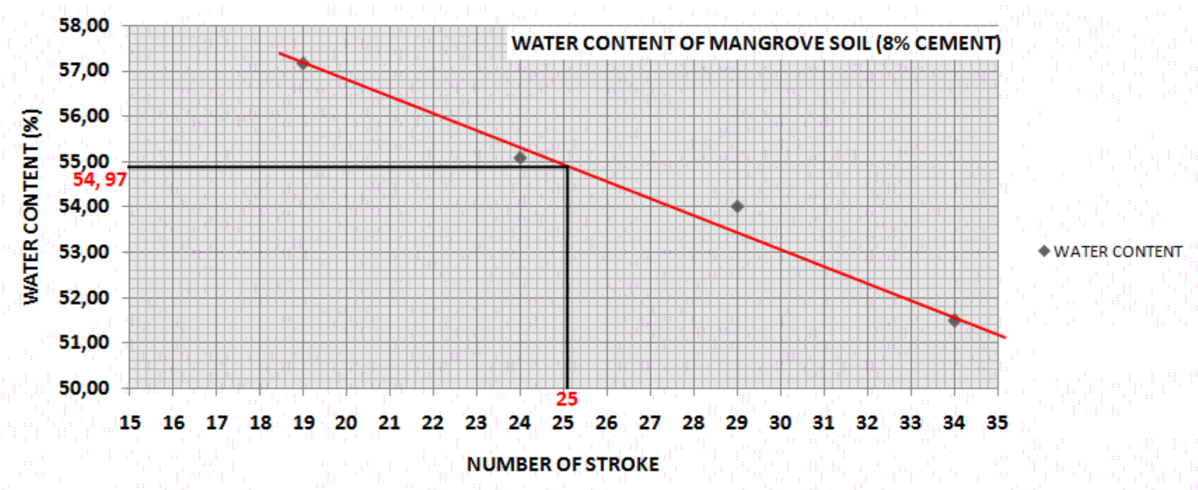

Figure 6: Water content of mangrove soil in its stabilized state (8% cement).

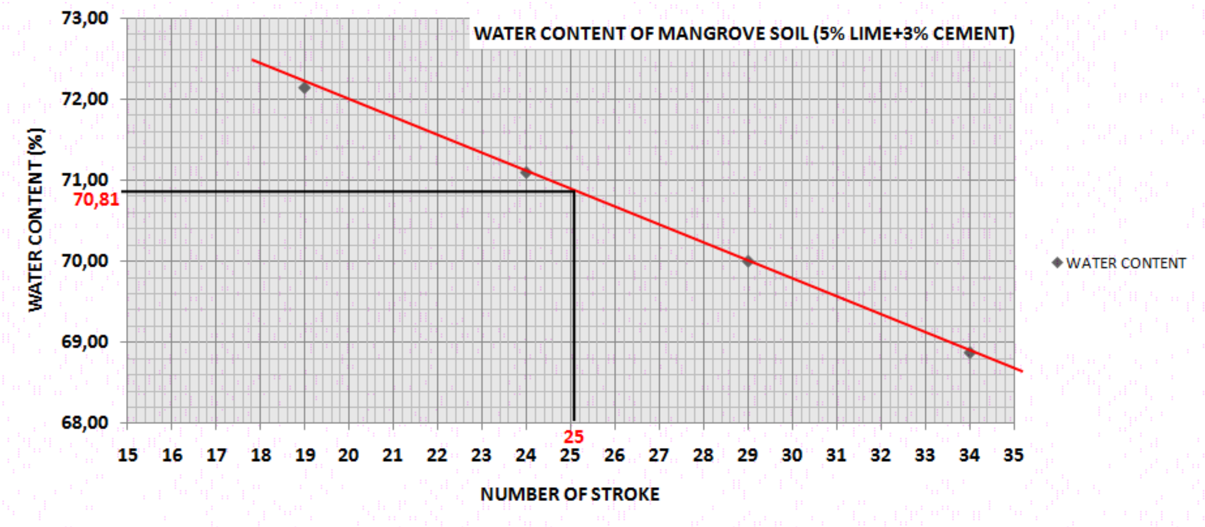

Figure 7: Water content of mangrove soil in its stabilized state (5% lime + 3% cement).

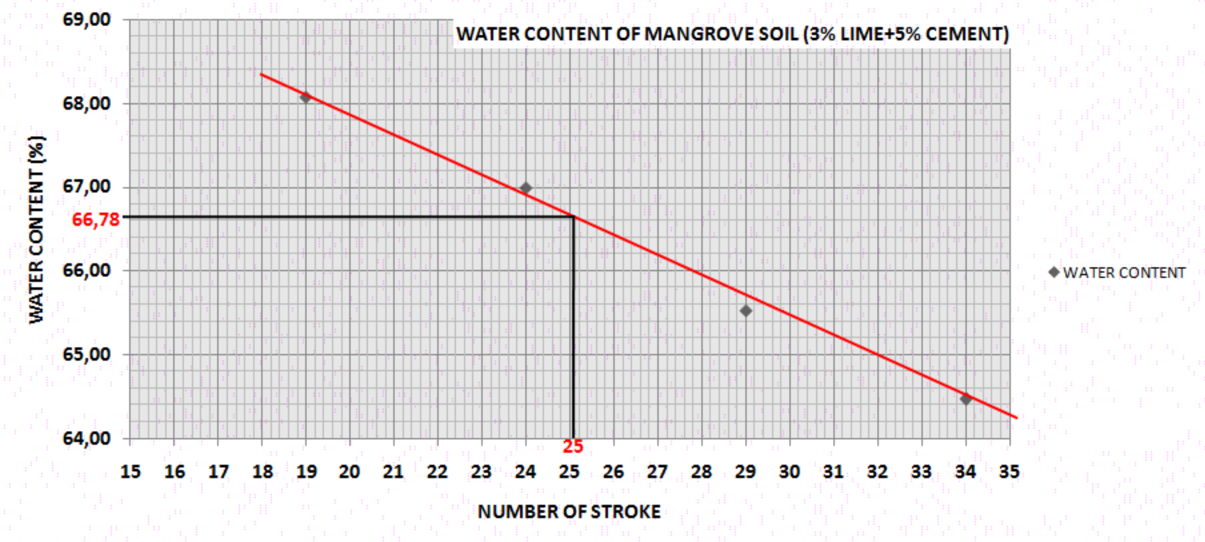

Figure 8: Water content of mangrove soil in its stabilized state (3% lime + 5% cement).

On the various figures mentioned above, we read the following water contents: 57.50% with 5% hydraulic lime; 47.03% with 8% hydraulic lime; 62.35% with 5% cement; 54.97% with 8% cement; 66.78% with 5% hydraulic lime + 3% cement and 70.81% with 3% lime + 5% cement.

The CBR indices obtained are: in the raw state is ICBR = 7.39; at its stabilized state ICBR = 21.26; It is reported that the higher the CBR index, the greater the earth's bearing capacity.[5]

These results show us that hydraulic lime is better than 32.5 JP-CIM cement in terms of stabilizing low-bearing earth (strength, stiffness, consistency and swelling) for use in construction.

In its raw state, Guinean mangrove soil has a humus content of 49.97mg/l, whereas this should not exceed 15mg/l for use in construction.[6] Its stabilization with 8% of hydraulic lime lowers its humus content to 1.89mg/l which means that lime produced at 1200°C is well suited for the stabilization of mangrove soil for the purpose of its use in building.

In the raw state of the mangrove soil, the granulometric analysis showed that the soil contains 55% clay, which does not favor the foundation of an infrastructure.[7]

In this raw state of this earth, the consistency index is Ic = 1.71, while in its stabilized state Ic = 2.01. It should be noted that the higher the consistency index, the more consistent the earth.[10] In the specific case of this study, the consistency index of mangrove soil in the stabilized state is higher than in the raw state. This means that for its use in construction, stabilization is necessarily necessary, especially with hydraulic lime.

The CBR index, in its raw state, is ICBR = 7.39. In the stabilized state, it is ICBR = 21.26. For the CBR index between 15 and 30 ($15 < ICBR < 30$) the earth can be used for the foundation layer and for the construction of habitat.[11]

3. CONCLUSIONS

Available almost everywhere in the Guinean coastal zone, the soil of the mangrove has only recently been the subject of fundamental research. The continual rise in the cost of energy and building materials has a lot to do with this gain in interest. But its sensitivity to water is the first obstacle to its use in construction. One of the possible solutions remains the stabilization of this mangrove soil by adding a binder (hydraulic lime or a bastard binder) to increase its mechanical and rheological characteristics. Found throughout coastal Guinea, there are different recipes for land stabilization, but that carried out with the addition of hydraulic lime or bastard binder has had satisfactory results. It was observed that the water infiltration time in the sample was prolonged. Which means that the material acquires the water-repellent character.

In the light of the results of our research work, we find that hydraulic binders and bastard binders have a major importance on the economic, technical and environmental levels in the stabilization of the mangrove soil.

This study can serve as a basis to better understand the advantage of using mangrove land in the construction of the Republic of Guinea.

REFERENCES

1. SUBBARAO C, Compactage et mécanique des milieux continus, thèse doct.-ingénieur, 24.11.1972, Univ. Grenoble (France), 173 p.
2. HONSALI A., RHATTAS K. TOURY J., Comportement du matériau terre. Application à la construction, Travail de fin d'études ENTPE, réf: 66, 1982, 147 p.
3. BEN HAMOU A., HAIROUF A, Contribution à l'étude des paramètres influant sur le comportement de la terre, Travail de fin d'études ENTPE, réf: 18, 1983, 110 p.
4. PINEDO J.C., MESBAH A, Briques de terre compressées. Influence de divers paramètres sur l'optimisation de la fabrication, Travail de fin d'études ÉNTPE, réf : 68, 1984, 105 p.
5. VENUAT M., Le traitement des sols à la chaux et au ciment, Publié par l'auteur, 66 av. C. Perrière, 92320 Châtillon-sous-Bagneux, 1980, 459 p.
6. Compactage des sols fins plastiques traités au liants hydrauliques en assises de chaussées, Journées d'information du LCPC, Nantes, 6-8 mai 1974, 35 p.
7. RIVALAIN M., Recherche de tests d'indentification physico-chimique des argiles à partir de l'essai au bleu de méthylène, Travail de fin d'études ENTPE , réf: 108, 1985, 85p.
8. TCHAKOUMEGNI R, MOKHTARI H, Étude de la résistance à la compression de sols reconstitués, bruts ou stabilisés au ciment en fonction du type et du pourcentage d'argiles, Travail de fin d'études ENTPE, réf : 77, 1985, 109 p.
9. OLIVIER M, MESBAH A., Caractérisation des briques de terre crue compressées par l'essai PROCTOR STATIQUE, Programme interministériel REXCOOP (France), Rapp. Recherche ENTPE, déc. 1985, 204 p.
10. OLIVIER M., Optimisation de la fabrication de briques de terre crue pour la construction, Communication au Colloque TropicaLS'85, Brasilia, févr. 1985 - Société brésilienne de Mécanique des sols, vol 2, technical sessions, p. 413-422.
11. OLIVIER M, Briques ~~dé~~deterre compressées, fabrication et comportement, Communication au 11e Colloque sur la Construction en terre, oct. 1984, ENTPE, 15 p.