Open Journal of Civil Engineering, 2025, 15(1), 56-69
https://www.scirp.org/journal/ojce
ISSN Online: 2164-3172
ISSN Print: 2164-3164

Physic Mechanical Behaviours of Raw Earth Bricks: Case of Laterite Stabilized with Gum Arabic and Reinforced with Sugarcane Bagasse in Chad

Djoui Taïpabé[1,2]*, Kouandété Valéry Doko[1], Tiambo Abbas Datchossa[1], Renonet Karka Bozabé[2], Mohamed Gibigaye[1]

[1]Laboratoire d'Energétique et de la Mécanique Appliquées (LEMA), University of Abomey-Calavi (UAC), Abomey-Calavi, Benin
[2]Laboratoire du Bâtiment et des Travaux Publics, Ecole Nationale Supérieure des Travaux Publics du Tchad, Ndjamena, Tchad
Email: *taipabedjouikepouring@gmail.com

How to cite this paper: Taïpabé, D., Doko, K.V., Datchossa, T.A., Bozabé, R.K. and Gibigaye, M. (2025) Physic Mechanical Behaviours of Raw Earth Bricks: Case of Laterite Stabilized with Gum Arabic and Reinforced with Sugarcane Bagasse in Chad. *Open Journal of Civil Engineering*, **15**, 56-69.
https://doi.org/10.4236/ojce.2025.151004

Received: January 3, 2025
Accepted: February 28, 2025
Published: March 3, 2025

Abstract

Laterite is very widespread in the manufacture of raw bricks. The objective of this article is to study the physics and mechanical behaviours of raw earth bricks using a composite material consisting of laterite stabilized with gum Arabic and reinforced with sugarcane bagasse. After the geotechnical tests and the formulation of the bricks, we carried out mechanical tests, which revealed that the highest values of compressive strength are obtained for a contribution of 25% (4.77 Mpa) and 30% (4.75 Mpa) of sugarcane bagasse and those of flexural strength of 25% (3.01 Mpa) and 30% (3.33 Mpa). The bricks are subjected to the tests of linear shrinkage, mass loss by immersion and abrasion, whose values vary respectively between 1.38% at 6%, from 16% to 6% and from 0.17 to 0.23 g/cm^2 depending on the addition of sugarcane bagasse from 5% to 30%. These results show that the mechanical and physical behaviors of the laterite-gum Arabic composite are improved by the addition of sugarcane bagasse, thus providing a reduction in mass loss by immersion. The study made it possible to understand that the composite would present explorable thermal potentialities given its linear shrinkage, a sign of the possible presence of pores.

Keywords

Laterite, Gum Arabic, Sugarcane Bagasse, Raw Earth Bricks, Stabilization

1. Introduction

Chad is a landlocked country in Central Africa and therefore has no access to the sea. This situation means that the supply of building materials is generally done through border transit, thus increasing the cost of these materials. Although a few factories producing building materials exist, prices remain exorbitant and the poverty experienced in Chad does not encourage an improvement in the situation [1] [2]. In this state of affairs, the population resorts to alternative materials that are easy to access both in terms of cost and availability. Hence, the use of earth materials is used in the construction of individual houses. One of these most used materials is laterite. Laterite is abundant in this region of Chad which is the subject of our study. It is a material that designates a gram of earthy mass of generally red colour characteristic of ferruginous soils [3] [4]. It results from an accumulation and sedimentation of rocks transported or existing on site and which are concretions or altered quartz grains. Its use in the world in general does not date from today. However, its mechanical performances are put to the test and this is reflected by the observation of structural and mechanical disorders on bricks made from this material [5]. These problems are being addressed through the process of stabilization with gum Arabic and reinforcing the sugarcane bagasse. Gum Arabic, it should be remembered, is a material derived from the sap of plants in the acacia family. More than a food emulsifier, it has particular properties, in particular its hydrophilic and hydrophobic dual character gives it a state of physico-chemical equilibrium [6] [7]. Gum Arabic is used as an admixture to laterite for the treatment of adobe house coverings. It was studied as an alternative binder to cement in the process of making laterite earth bricks in order to evaluate its effects in relation to durability properties [8]. It plays an important role in reducing dry density [9]. The addition of sugarcane bagasse to the laterite plus gum Arabic mixture provides reinforcement in the production of this composite material [10]. Sugarcane bagasse is a fibrous residue from the extraction of sugarcane juice. Given its fibrous potential, it presents a wide morphological heterogeneity consisting of fiber bundles and structural constituents, which are precisely involved in the mechanical behaviour of the composite [11]. In addition, bagasse, a direct waste from the sugar factory, has a humidity of 48%, an apparent specific weight estimated at between 200 kg/m^3 [12].

2. Materials and Methods

2.1. Presentation of the Study Area

The study area (**Figure 1**) is in the southwest of Chad in the Mayo-Kebbi West region. It has an average annual rainfall that seems stable around 700 to 800 mm with an average annual temperature of 38˚C. Pala (latitude 9˚21'0" and longitude 14˚58'0") is the capital of the region with a population of more than 50,000 inhabitants. This region borders Cameroon.

2.2. Materials

2.2.1. Laterite

It is taken from the quarry located behind the old Coton Tchad factory. Two types of textures are observed: gravelly laterites and rocky laterites (**Figure 2**).

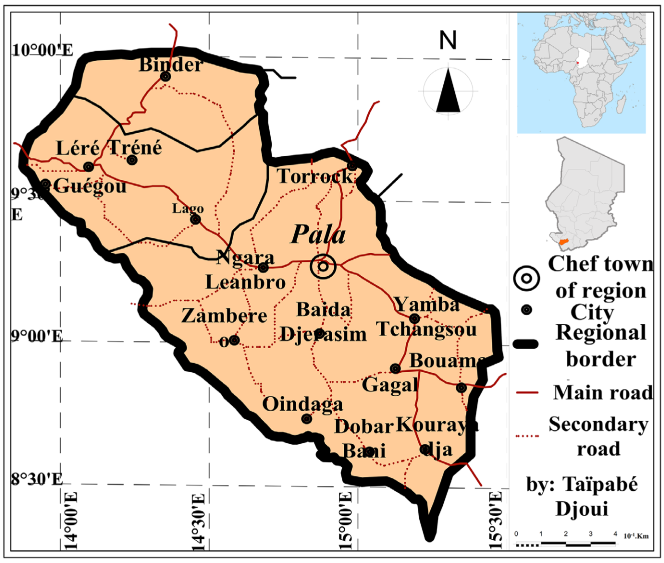


Figure 1. Map of the study area.

Figure 2. Rocky laterite (a); gravelly laterite (b).

Gravelly laterites are composed of pisoliths, *i.e.*, small isolated hard fragments, coated or scattered in a fine soil. Meanwhile, rocky laterites are coherent and hard materials, similar to soft rocks, which can explode with a hammer or by exerting any force (explosive), and reduced to rubble and crushed stones, all run or calibrated [13]. For our study, the gravel type was used due to its immediate availability and ease of application.

2.2.2. Gum Arabic

Gum Arabic (**Figure 3**) is a natural heteropoly molecular polymer exuded by the Senegalese acacia plant. This plant is widespread in the Sahelian areas and the Mayo Kebbi West region (Pala). The gum is made up of approximately 39% to 42% galactose, 24% to 27% arabinose, 12% to 16% rhamnose, 14% to 16% glucuronic acid (which gives it its anionic character), 1.5% to 2.6% protein, 2.22% to 0.39% nitrogen and 12.5% to 16% water, for an average molecular mass of 200 to 300 kilo Daltons and a specific mass of 13.5 KN/m^3 [14]. **Table 1** shows the chemical composition of gum Arabic.

Figure 3. Gum Arabic.

Table 1. Chemical composition of the gum Arabic used.

Sample	Rhamnose	Arabinose	Galactose	Glucose	Ac glucuronic acid
Unit	mg/l	mg/l	mg/l	mg/l	mg/l
GA	26.14	24.31	10.82	20.94	0.85

2.2.3. Sugarcane Bagasse

Sugarcane bagasse is the waste of sugarcane. Sugarcane is a reed 3 to 4 meters high, straight at the end of growth but bends towards maturity. The stem is cylindrical and varies in size between 2 and 6 cm. Although the region does not currently have a sugar manufacturing plant, its production in the locality is very abundant, part of which is intended for the factory of the Chad Sugar Company, in the extreme south of the country (Sarh) and another part for local consumption. The harvest period is often between November and December (dry period). If we consider mature sugarcane without its leaves, it contains 90.44% of sweet juice against 9.56% of woody (**Table 2**) [15]. **Figure 4** shows sugarcane bagasse, and **Table 2** shows the percentage of sugarcane constituents.

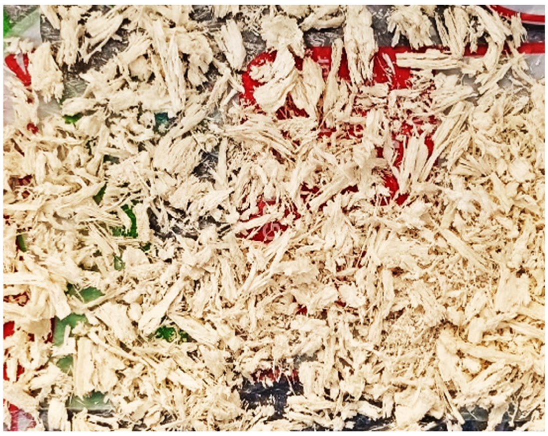


Figure 4. Sugarcane bagasse.

Table 2. Percentage constituents of sugarcane.

Components	Percentage (%)
Water	71.04
Crystallizable sugar	18.02
Woody	9.56
Albumin and other nitrogenous substances	0.55
Fatty and colouring resinous materials	0.35
Mineral salts	0.48

2.3. Methods

2.3.1. Standards

Table 3 presents a set of standards that allowed us to conduct our tests.

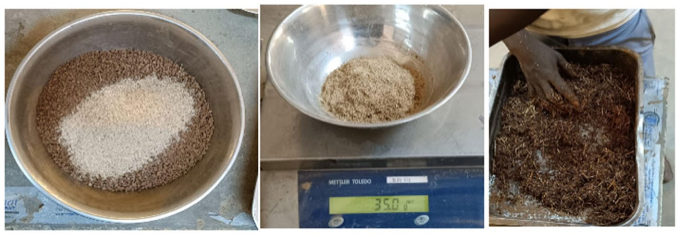
Table 3. Testing standards.

Tests	Standards
Granulometry	NF EN ISO 14688-1 [16], p. 14688
Atterberg Limits	NF P94-051 [17]
Moisture content of laterite	NF EN ISO 18134-3 [18], p. 13
Formulation	XP P13-901: 2022 [18], p. 1
Apparent density	NF EN ISO 11272 [19], p. 11
Compressive strength	NMX-C-432-ONNCCE-2002 [20]
Flexural strength	BS EN 12372:2022 [21]
Linear shrinkage on drying	XP P13-901: 2022 [18], p. 13
Abrasion resistance	XP P13-901: 2022 [18]
Water-proof by immersion	XP P13-901: 2022 [18]

2.3.2. Standards

They were made according to XP P13-901: 2022. The mixture of components (laterite plus powdered gum Arabic) was done dry after being placed in an oven at 105˚C for 24 hours. Gum Arabic (7%) in powder form with dimensions varying between 0.2 and 0.6 mm after grinding, was added to the laterite for an initial dry mix (Figure 5). This percentage of gum Arabic is defined by the authors of the literature as being the threshold for optimum compressive strength. This dry mix allows for a uniform distribution of the fine particles of the lateritic matrix before the mixture sets when water and bagasse are added. The length in millimeters of the bagasse is 2.50 to 10.20 for a diameter of 0.55 to 3.50 mm. It is important to ensure a homogeneous distribution of the constituents before molding the bricks in order to avoid the agglomeration of the fibers between them.

Then, once the two components have been homogenized, water is added reasonably according to the water content, then gradually sugarcane bagasse until a nearly homogeneous paste is obtained and finally the moulding in 16*4*4 cm^3 (Figure 6). Table 4 shows the proportions of the materials during the operation.



(a) (b) (c)

Figure 5. Mixture of Laterite and gum Arabic (a); addition of sugarcane bagasse (b); mixture with addition of water (c).

Table 4. Formulation.

Formulation	Laterite	Sugarcane bagasse	Gum Arabic	Water	Number of test tubes
E	100%	0%	7%	12%	15
E1	100%	5%	7%	15%	15
E2	100%	10%	7%	15%	15
E3	100%	15%	7%	20%	15
E4	100%	20%	7%	25%	15
E5	100%	25%	7%	30%	15
E6	100%	30%	7%	30%	15

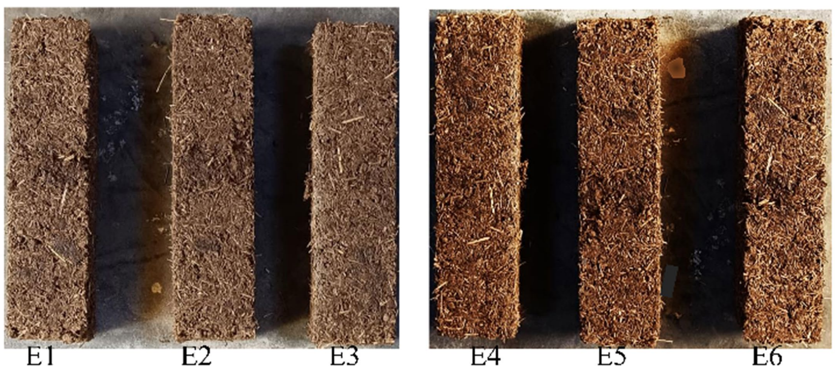


Figure 6. Sample of test tubes 16*4*4 cm^3.

2.3.3. Methodological Framework of the Characterization Procedure

As indicated above in Table 3, we started with the granulometric test in order to determine the different grain diameters of the laterite material (NF EN ISO 14688-1). The Atterberg limits were obtained according to the NF P94-051 standard. These conventional physical constants mark the thresholds between the passage of soil from the liquid state to the plastic state (Wl) and the passage from the plastic state to the solid state (plasticity limit Wp). The natural water content makes it possible to know the mass of free water eliminated by drying in an oven at a temperature of 105˚C. Since bricks are subjected to stresses in construction, it is therefore important to understand their physic mechanical behaviour by determining their compressive strength (NMX-C-432-ONNCCE-2002) and flexural strength (BS EN 12372: 2022) using the apparatus shown in Figure 7, their linear shrinkage on drying according to the principle described in XP P13-901: 2022, their abrasion resistance (XP P13-901: 2022) and their resistance to water by immersion (XP P13-901: 2022), the devices of which are shown diagrammatically in Figure 8 and Figure 9 respectively.

Figure 7. Experimental device for compression testing.

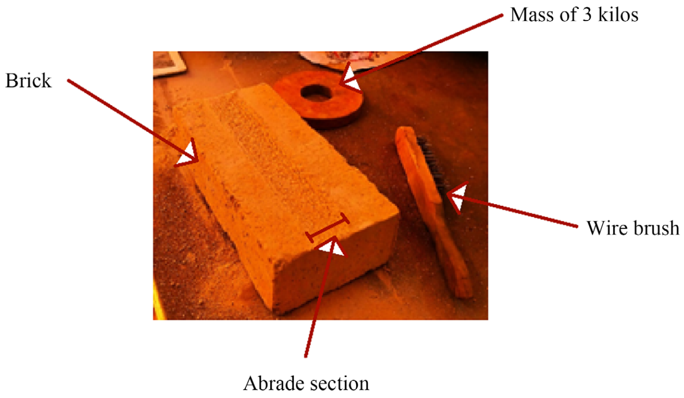


Figure 8. Abrasion test device.

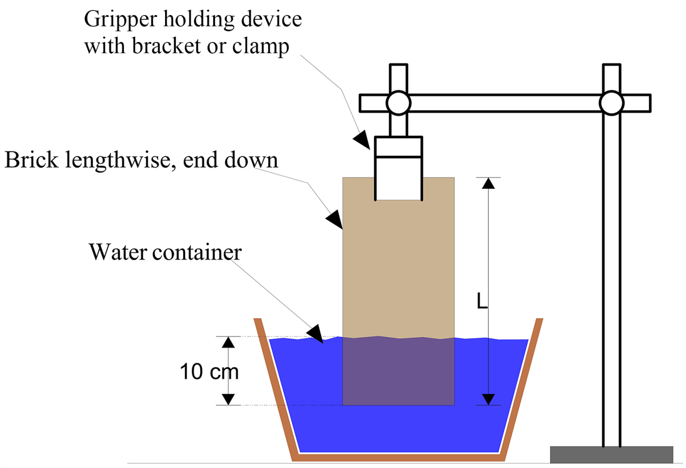


Figure 9. Immersion test device [18].

3. Results and Discussions

3.1. Geotechnical Characterizations of Laterite

The results obtained from some geotechnical tests are listed in Table 5.

Table 5. Geotechnical results.

Characterizations	Results
Laterite granulometry	21% clay; 17% silt; 62% sand
Atterberg Limits	Wl (%) = 39; Wp (%) = 22.08; Ip (%) = 16.92
Moisture content of laterite	1.36% ± 0.03%

The values of the Atterberg limits are reported in Figure 10. The plasticity diagram (Figure 10) allows us to position these values in its coordinates. It suggests that the material is well suited for earth construction needs [18].

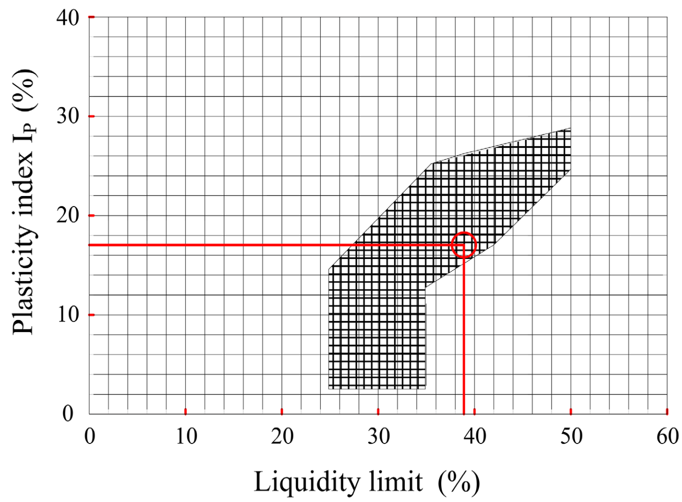


Figure 10. Plasticity diagram.

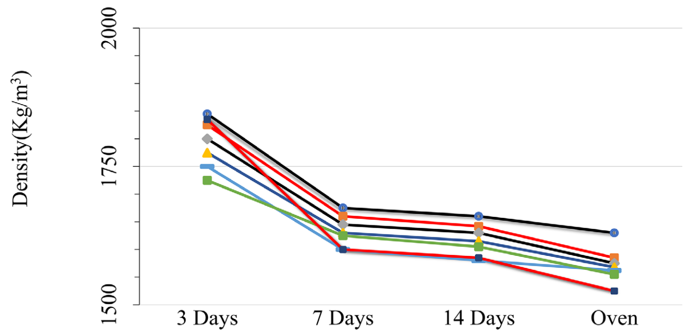
3.2. Physical and Mechanical Characterizations

3.2.1. Density

The density after passage in the oven at 100˚C varies from 1525 to 1630 kg/m^3 (Figure 11). However, at three days of age, the values are much higher than those after passage in the study. This variation is explained by the capacity for shrinkage during drying as mentioned [22] [23].

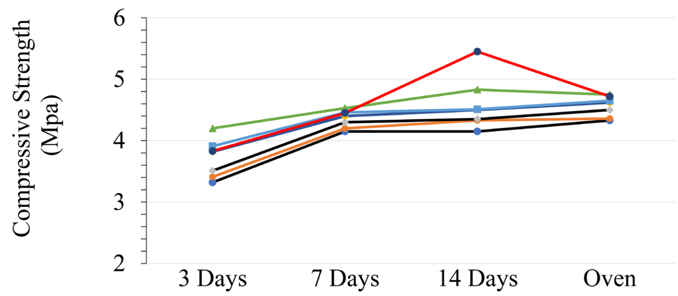
3.2.2. Compressive and Flexural Strength

The values of the determined compression (Figure 12) and bending (Figure 13) tests vary according to the percentage of sugarcane bagasse reinforcement. The maximum value for compression is 4.70 MPa for a percentage of 25% of sugarcane bagasse, while that of the bending resistance is 3.33 MPa for an addition of 30% of sugarcane bagasse after passing through the oven at 105˚C. These results are better thanks to the addition of sugarcane bagasse than those obtained by [24]-[26].



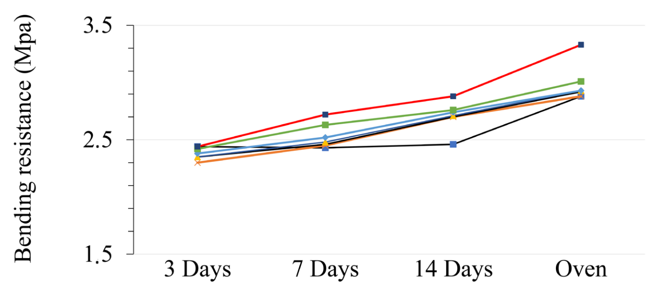
	3 Days	7 Days	14 Days	Oven
Sample E only	1845	1675	1660	1630
E1	1825	1660	1642	1585
E2	1800	1645	1630	1575
E3	1775	1630	1615	1568
E4	1750	1600	1580	1562
E5	1725	1625	1605	1555
E6	1835	1600	1585	1525

Figure 11. Density.



	3 Days	7 Days	14 Days	Oven
Sample E only	3.32	4.15	4.15	4.33
E1	3.41	4.2	4.33	4.36
E2	3.51	4.3	4.35	4.5
E3	3.82	4.4	4.5	4.62
E4	3.91	4.46	4.51	4.65
E5	4.2	4.53	4.83	4.75
E6	3.83	4.45	5.45	4.72

Figure 12. Compressive strength.



	3 Days	7 Days	14 Days	Oven
Sample E only	2.44	2.43	2.46	2.88
E1	2.3	2.45	2.7	2.88
E2	2.35	2.46	2.7	2.92
E3	2.35	2.48	2.71	2.93
E4	2.38	2.52	2.74	2.93
E5	2.42	2.63	2.76	3.01
E6	2.44	2.72	2.88	3.33

Figure 13. Bending resistance.

3.2.3. Linear Withdrawal

Since the raw materials constituting our composite material exhibit plastic behaviour, the shrinkage test is carried out on the test pieces produced [18]. This parameter allows to have an exact idea of the real dimensions of the bricks after drying. By carrying out a daily measurement of the length of the test pieces until the complete drying of the brick, the value of the linear shrinkage RL is determined, expressed as a percentage presented in the form of a graph in **Figure 14**.

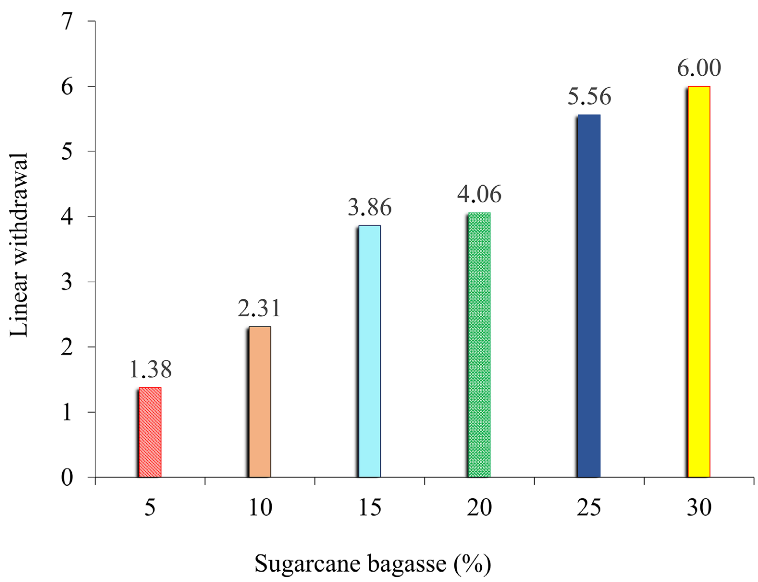


Figure 14. Linear withdrawal.

We observed that the more sugarcane bagasse is added to the composite, the more its linear shrinkage increases. This shrinkage could be explained by the possible presence of pores in the composite material, in addition to the physical and mechanical characteristics of sugarcane bagasse with a low apparent density (200 kg/m^3) [12] [27].

3.2.4. Mass Loss by Immersion

We see in **Figure 15** that the mass loss by immersion varies from 6% to 16% depending on the percentages of sugarcane bagasse input. This variation is disproportionate depending on whether there is more bagasse; there will be less mass loss and vice versa. This is why at 5% sugarcane bagasse; we obtain 16% mass loss. At 30% sugarcane bagasse, we only have a 6% mass loss. This is explained by the fact that the more fibers there are in the composite, the more the constituents aggregate together in addition to the binding action of gum Arabic as the authors point out [27] [28].

3.2.5. Abrasion Test

This test is all the more important because it allows us to simulate the wear of the material over time. In order to classify our material to the XP 13-901 standard, we use the class defined in **Table 6**. **Figure 16** shows the results.

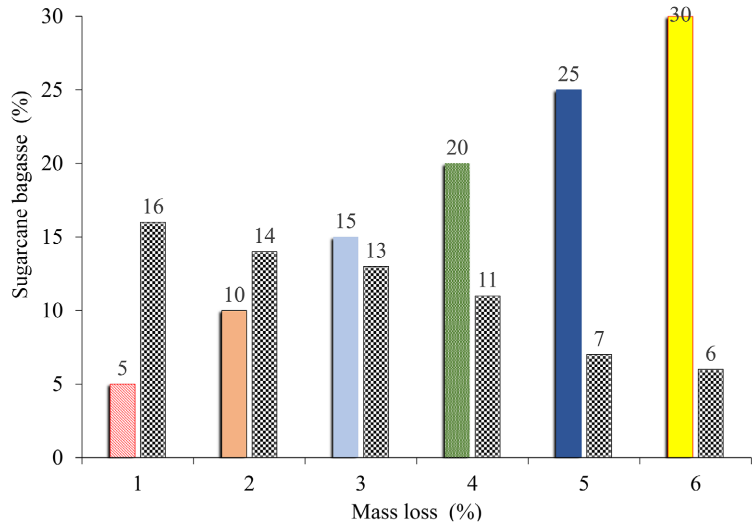


Figure 15. Mass loss (%).

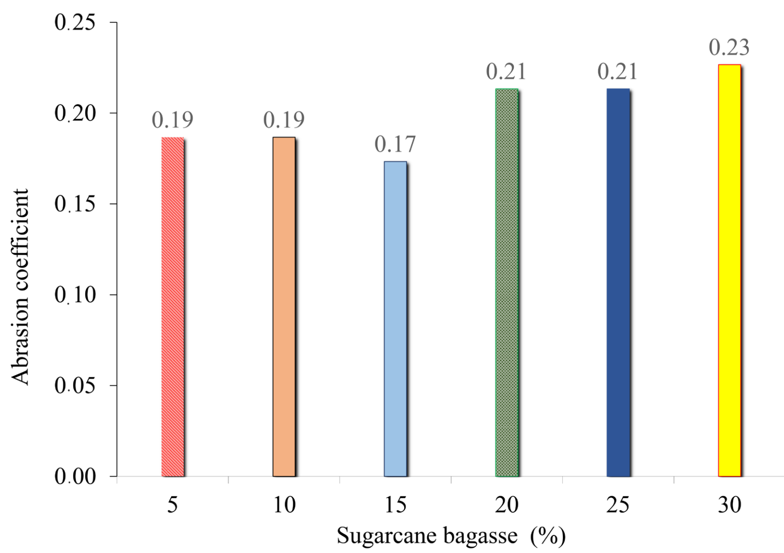


Figure 16. Abrasion test.

Table 6. Abrasion resistance category.

Abrasion coefficient (g/cm^2)	Abrasion resistance category
≤0.14	Ab1
≤0.2	Ab2
≤0.5	Ab3

Based on this result, our material is class Ab3 [18].

4. Conclusion

In short, the objective of this article was to study the physics and mechanical behaviours of raw earth bricks using a composite material consisting of laterite stabilized with gum Arabic and reinforced with sugarcane bagasse. Determination of the Atterberg limits gives: Wl (%) = 39; Wp (%) = 22.08 with a plasticity index Ip (%) = 16.62. The plasticity index is between 15 and 40, and the soil is said to be plastic. The values inserted in the spindle of the plasticity indices of the earth indicate the soil studied is recommended for bricks. The maximum compression value is 4.70 MPa for a percentage of 25% of sugarcane bagasse, while that of the flexural strength is 3.33 MPa for a contribution of 30% of sugarcane bagasse after passage in the oven at 105˚C. An increasing variation of these values demonstrates that the addition of sugarcane bagasse in the laterite and gum Arabic mixture increases the mechanical and physical resistances of the bricks. The abrasion test allowed us to classify our bricks as class Ab3 with an abrasion coefficient ≤ 0.5 g/cm^2, which confirms that the more sugarcane bagasse the bricks contain, the more they are subject to degradation due to wear and, at the same time, loss in mass. This study made it possible to understand the possibilities of using lateritic earth bricks with plant fibers as reinforcement.

Credit Authority Contribution Statement

TAÏPABE Djoui: Writing-review & editing, Writing-original draft, Methodology, Investigation; DOKO Kouandété Valéry Writing-original draft, Methodology, Investigation., DATCHOSSA Tiambo Abbas: Writing-original draft, Methodology; GIBIGAYE Mohamed: Writing-original draft, Methodology.

Acknowledgements

The authors are grateful to all laboratory technicians of "Laboratoire d'Energétique et de Mécanique Appliquées (LEMA)" of University of Abomey-Calavi (UAC) Benin, and those of the "X-TECHLAB", Sémé City, Benin for their constant help in the realization of geotechnical and mechanical tests.

Conflicts of Interest

The authors declare no conflicts of interest regarding this paper.

References

[1] Institut National de la Statistique, des Etudes Economiques et Demographiques (2024) Bulletin menssuel de l'indice National Harmonisé des Prix à la Consommation (INHPC) Tchad-Août. https://www.inseed.td/index.php/component/jdownloads/category/7-documents-et-publications-demographique?Itemid=-1

[2] Karka, B.R. and Djoui, T. (2019) Modèle de construction d'habitats en terre: Cas d'adobe manuel en Afrique au sud du Sahara. *International Journal of Innovation and Applied Studies*, **26**, 883-887.

[3] Musbau, K.D., Kolawole, J.T., Babafemi, A.J. and Olalusi, O.B. (2021) Comparative Performance of Limestone Calcined Clay and Limestone Calcined Laterite Blended Cement Concrete. *Cleaner Engineering and Technology*, **4**, Article ID: 100264. https://doi.org/10.1016/j.clet.2021.100264

[4] Fall, M., Sarr, D., Cissé, E.M. and Konaté, D. (2021) Physico-Mechanical Characterization of Clay and Laterite Bricks Stabilized or Not with Cement. *Open Journal of Civil Engineering*, **11**, 60-69. https://doi.org/10.4236/ojce.2021.111004

[5] Abhilash, H.N., McGregor, F., Millogo, Y., Fabbri, A., Séré, A.D., Aubert, J.E., *et al.* (2016) Physical, Mechanical and Hygrothermal Properties of Lateritic Building Stones (LBS) from Burkina Faso. *Construction and Building Materials*, **125**, 731-741. https://doi.org/10.1016/j.conbuildmat.2016.08.082

[6] Sánchez Calvillo, A., Alonso Guzmán, E.M., Navarro Ezquerra, A., Ruiz Mendoza, M., Martínez Molina, W., Álvarez Galindo, J.I., *et al.* (2024) Physical-Chemical, Mechanical and Durability Characterization of Historical Adobe Buildings from the State of Michoacan, Mexico. *Journal of Building Engineering*, **86**, Article ID: 108802. https://doi.org/10.1016/j.jobe.2024.108802

[7] Montenegro, M.A., Boiero, M.L., Valle, L. and Borsarelli, C.D. (2012) Gum Arabic: More than an Edible Emulsifier. In: Johannes, C. and Verbeek, R., Eds., *Products and Applications of Biopolymers*, InTech, 953-978. https://doi.org/10.5772/33783

[8] Rimbarngaye, A., Mwero, J.N. and Ronoh, E.K. (2021) Effect of Gum Arabic as Partial Replacement of Cement on the Durability Properties of Compressed Laterite Blocks. *Open Journal of Civil Engineering*, **11**, 398-410. https://doi.org/10.4236/ojce.2021.114023

[9] Rimbarngaye, A., Mwero, J.N. and Ronoh, E.K. (2022) Effect of Gum Arabic Content on Maximum Dry Density and Optimum Moisture Content of Laterite Soil. *Heliyon*, **8**, e11553. https://doi.org/10.1016/j.heliyon.2022.e11553

[10] Theodore, T., Mozer, C., Joseph, P., Njie, J., Clins, N., Parfait, Z.E., *et al.* (2020) Extraction and Characterization of Bagasse Fibres from Sugar Cane (*Saccharum officinarum*) for Incorporation into a Mortar. *Open Journal of Applied Sciences*, **10**, 521-533. https://doi.org/10.4236/ojapps.2020.108036

[11] Sanjuán, R., Anzaldo, J., Vargas, J., Turrado, J. and Patt, R. (2001) Morphological and Chemical Composition of Pith and Fibers from Mexican Sugarcane Bagasse. *Holz als Roh-und Werkstoff*, **59**, 447-450. https://doi.org/10.1007/s001070100236

[12] Hugot, E. (1987) La Sucrerie de cannes. 3e Edition, Ed. Tec & Doc.

[13] Issiakou, M.S., Saiyouri, N., Anguy, Y., Gaborieau, C. and Fabre, R. (2015) Etude des matériaux latéritiques utilisés en construction routière au niger: Méthode d'amélioration. Présenté à Rencontres Universitaires de Génie Civil. https://hal.science/hal-01167576v1

[14] Bozabe, R.K., Toukourou, C.A., Gbaguidi, G.A. and Hounkonnou, M.N. (2013) Étude des caractéristiques physico-mécaniques des tuiles en micro-béton fabriquées localement à base de la gomme arabique. *Afrique Science*, **9**, 1-15.

[15] de Casaux, C. and M.D.C.X. (1781) Essai sur l'art de cultiver la canne et d'en extraire le sucre. Par M. D. C. X. Clousier. https://books.google.fr/books?id=bixFAAAAYAAJ

[16] «NF EN ISO 14688-1», Afnor EDITIONS. https://www.boutique.afnor.org/fr-fr/norme/nf-en-iso-146881/reconnaissance-et-essais-geotechniques-identification-et-classification-des/fa186763/82671

[17] «NF EN ISO 18134-3», Afnor EDITIONS. https://www.boutique.afnor.org/fr-fr/norme/nf-en-iso-181343/biocombustibles-solides-methodes-de-determination-de-la-teneur-en-humidite-/fa178111/46334

[18] «XP P13-901», Afnor EDITIONS. https://www.boutique.afnor.org/fr-fr/norme/xp-p13901/blocs-de-terre-comprimee-

pour-murs-et-cloisons-definitions-specifications-m/fa120503/487

[19] «NF EN ISO 11272», Afnor EDITIONS. https://www.boutique.afnor.org/fr-fr/norme/nf-en-iso-11272/qualite-du-sol-determination-de-la-masse-volumique-apparente-seche/fa179622/43109

[20] Nina, «NMX-C-432-ONNCCE-2002», Normalización. https://platiica.economia.gob.mx/normalizacion/nmx-c-432-onncce-2002/

[21] «BS EN 12372:2022-TC|31 Mar 2022|BSI Knowledge». https://knowledge.bsigroup.com/products/natural-stone-test-methods-determination-of-flexural-strength-under-concentrated-load-2?version=tracked

[22] Ali, A., Benelmir, R., Tanguier, J.-L. and Todjiba, A. (2017) Caractéristiques mécaniques de l'argile de Ndjamena stabilisée par la gomme arabique. *Afrique Science*, **13**, 330-341.

[23] Joshaghani, A. and Moeini, M.A. (2018) Evaluating the Effects of Sugarcane-Bagasse Ash and Rice-Husk Ash on the Mechanical and Durability Properties of Mortar. *Journal of Materials in Civil Engineering*, **30**. https://doi.org/10.1061/(asce)mt.1943-5533.0002317

[24] Cisse, E.H.A.A., Traore, P.T., Ghabo, A., Ndiaye, M. and Diagne, I. (2024) Thermo-mechanical Characterization of Laterite Matrix Reinforced with Typha Material for Thermal Insulation in Building. *Materials Sciences and Applications*, **15**, 450-463. https://doi.org/10.4236/msa.2024.1510030

[25] Adebola, J.A., Ikumapayi, C.M. and Arum, C. (2023) Effectiveness of Rice Husk and Sugarcane Bagasse Ashes Blended Cement in Improving Properties of Concrete. *Journal of Materials Science and Chemical Engineering*, **11**, Article No. 8. https://doi.org/10.4236/msce.2023.118001

[26] Bilba, K., Rodier, L., Onésippe, C. and Arsène, M.A. (2015) Thermal and Mechanical Behaviors of Cementitious Composites Reinforced with Bagasse. *Key Engineering Materials*, **668**, 330-340. https://doi.org/10.4028/www.scientific.net/kem.668.330

[27] Acharya, S.K., Mishra, P.P. and Mehar, S.K. (2008) The Influence of Fiber Treatment on the Performance of Bagasse Fiber-Reinforced Polymer Composite. *Journal of Reinforced Plastics and Composites*, **28**, 3027-3036. https://doi.org/10.1177/0731684408094221

[28] Ceti, C.A.M., Honguelet, A.S.D., Ngoro-Elenga, F., Nsongo, T., Eboungabeka, A.D., Elenga, H., *et al.* (2024) Influence of Sugarcane Bagasse Fibers on the Mechanical Strength and Porosity of Concrete Made with Forspak 42.5 N Cement in the Republic of Congo. *Advances in Materials Physics and Chemistry*, **14**, 249-263. https://doi.org/10.4236/ampc.2024.1411018