Effect of Environmental Temperature and pH Water on Compressive Strength of Clay Brick Mixed Wood Chips Mahogany based Building Materials

Gilbert Ganga*, Hilaire Elenga**, Timothée Nsongo*** & Thomas Tamo Tatsiete****

*University Marien NGOUABI / National High School of Polytechnic, Brazzaville, CONGO. E-Mail: ganga.gilbert{at}yahoo{dot}fr
**University Marien NGOUABI / Center of Geological and Mining Research, Brazzaville, CONGO. E-Mail: hilaire_elenga{at}yahoo{dot}fr
***University Marien NGOUABI / Center of Geological and Mining Research, Brazzaville, CONGO. E-Mail: nsongo{at}yahoo{dot}com
****University of Yaoundé1 / National High School of Polytechnic, Yaoundé, CAMEROUN. E-Mail: thom2t{at}yahoo{dot}fr

***Abstract*—**Bricks using local materials were manufactured in order to reduce the cost of the housing and take into account the waste wood management to protect the environment. Wood Chips were built-in clay bricks building materials in order to study the effect of environmental temperature on compressive strength. The resistance tests in simple compression were made on the parallel epipedic test-tubes out of ground, stabilized with different percentage of cement with incorporation to various percentages of wood chips (mahogany), using a universal press. The obtained results were presented and discussing. These results shows that the incorporation of mahogany wood chips in the clay brick decrease the compressive strength at air atmosphere temperature. It was found that the compressive strength can be increase when the environment temperature was increase below 25^0C. The decrease of compressive strength was attributed to the content acidity in the wood chips.

***Keywords*—**Brick Clay; Building Materials; Cement; Compressive Strength; Environment; Mahogany; Wood; Wood Chips.

I. INTRODUCTION

CENTRAL Africa is a timber-producing sub-region. Wood industries generate a great quantity of wood waste which management has serious pollution problems. The use of waste wood in construction can be an alternative for the protection of the environment. The incorporation of wood waste in building materials has been the subject of diverse studies [Ngoma & Poungui, 2011; Ganga, 2013], most of them were focused on the influence on the mechanical properties [Meukam, 2004; Taoukil et al., 2011; Ganga, 2013; Nzabana, 2013]. The purpose of this work is to minimize the cement content in brick clay in order to study the effect of environment temperature on compression strength. The choice of mahogany is justified by its extensive use in the wood industry which release huge waste [Gaye, 2001; Goteicha et al., 2007; Batékidila, 2009; Mambouana, 2010]. The motivation for this study is based on the fact that we found no reference to previous work on the recycling of waste mahogany in Central Africa. The objectives of this work are: at environmental, geotechnical and economical level: to Manage wood chips as an alternative to protect environment; to incorporate the wood chips in the building construction industry in order to use brick based clay materials as acoustic barriers to protect against noise pollution and to reduce the cost of building construction by using local brick materials. The contribution of this manuscript is to find a experimental conditions for improving compressive strength of brick clay materials mixed to wood chips in building construction.

II. MATERIALS AND METHODS

The experimental device manufacturing test is made up of the following components: a tank, a brick mold, a wooden device, a screed, a precision scale and a graduated cylinder and water from the BCBTP drilling, an electronic KERN KB scale type of the (10100g,d = 0.1 g) range, a trowel. The earth material used for the manufacture of bricks was made at air atmosphere and various environment temperature. A mass of 6 kg of land was used; this mass corresponds to 12 small bricks at 3 samples per test and drying time. The water content is determined by the Proctor: 22%.The test for determining the compressive strength machine is a universal

G.I.M. press brand (General Engineering Measurement), used according to the NF EN 196-1, the compressive force of 250kN (Figure 3). It is equipped with an indicator device which is constructed so that the previous value of the failure of the specimen is shown on the screen after returning to zero load. This may be achieved by using an indicator of a maximum pressure monitor or on a digital memory device (computer). The test machine, the charging is controlled manually, is provided with a measuring device controlling the loading speed.16 cm x 4cm x4cm parallelepiped small bricks are centered between the plates of the press and loaded continuously at an average speed of 0.20 MPa / s by a compressive force to crush. Calculating thereafter the compressive strength, which is the ratio between the compressive stress and the maximum section and the cross section of the crushed test device?

III. Operating Procedure of Compression Test

After measuring the size of the brick clay sample, weighed, and then placed on the plate of the press. Then start the test compression control computer is controlled. A compression test is carried out in two different phases: the first phase, which depends on the operator, allows to bring the piston in integral contact to compress the sample, placed on the plate of the press until the timber is well stuck. During this phase, the counter of the applied load is set to zero. The second phase is also initiated by the operator. This is the phase of the course of the compression; the piston instantly compresses the sample to overcome the maximum resistance, the resulting rupture is automatically stopped. The computer after data processing using software, displays the load - deformation curve, the values of the module of the resistance of charge (RC) in N/mm^2 and the breaking load in kN.

IV. Results and Discussion

4.1. Influence the Content of Wood Chips on the Compressive Strength at Air Atmosphere

Figure 1 shows the evolution of compressive strength as a function of the content of chips in air atmosphere when the cement content is varied.

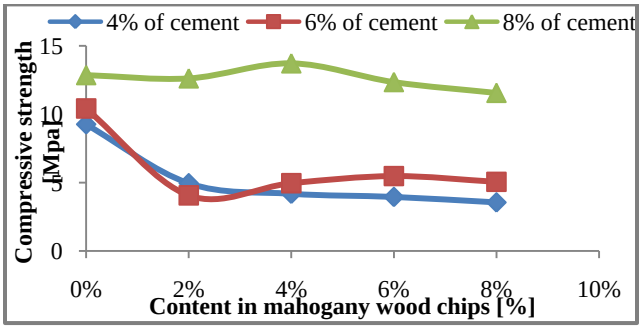

Figure 1: Variations in Compressive Strength as a Function of Content Chips

The compressive strength decreases with increasing content of chips to 4 % cement, it passes through a minimum of 6% of cement and up to 8 %.

This result is consistent with that reported in the literature [Tamba et al., 2007; Ngoma & Poungui, 2011; Khelifi Belouettar, 2012].

4.2. Influence the Environment Temperature on the Compressive Strength of Brick Clay

We have varied the environment temperature of the clay brick mixed with chips. We then conducted compression tests on samples for every temperature. Figure 2 shows the obtained results. These results show that it is possible to increase the compressive strength when the environment temperature increase, whatever the nature of the waste (wood chips).

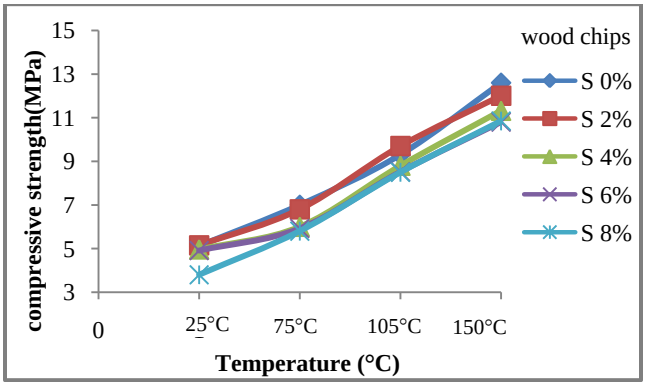

Figure 2: Variations of Compressive Strength as Function of Temperature at Various Wood Chips Content

4.3. Effect of Use Water pH for made Brick

We analyzed water from sample water drilling and the one which was immersed samples of mahogany chips. We then measured the chemical parameters of the water. The results obtained are given in Table 1. These results show that the chemical components in water drilling is low compared to the water containing wood chips mahogany; and show that the water becomes highly acidic after immersion of mahogany wood.

Table 1: Measured o Chemical Parameters for the Water which is using to make Brick Clay

	pH	t°	Ca^{2+}	K^{+}	Mg^{2+}	Mn^{2+}	PO_4^{3-}	Al^{3+}
Water drilling with emersing wood mahogany chips	3,67	26,2	13mg/L	5,7mg/L	21mg/L	0,05mg/L	1,05mg/L	0,8mg/L
Water drilling	7,08	26,8	6mg/L	0,123mg/L	3,66mg/L	0,02mg/L	0,008mg/L	0,043mg/L

The compressive strength of brick made with water of drilling and water of the slightly acid (pH= 3.67) where measured. The obtained results are presented on figure 3. This results show that using the acid water increase the compressive strength.

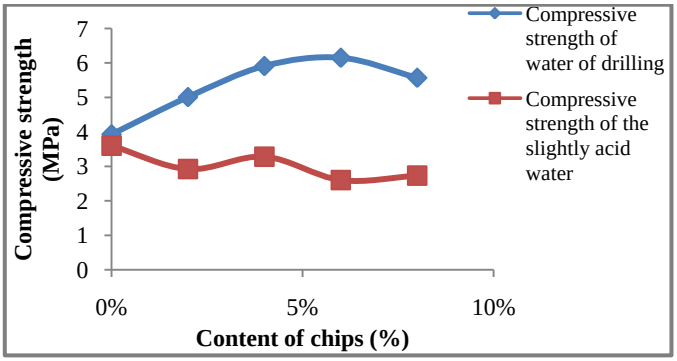

Figure 3: Variation of Compressive Strength as Function of Wood Chips Content and Water Nature

The compressive strength has been measured as a function of the content of chips mahogany at different temperature. The results in figures 5, 6, 7 and 8 show that the compressive strength decreased with increasing the content of waste wood. The compressive strength as a function of the chip content seems to stabilize at 75°C.

The compressive strengths increase with temperature that is explained by the fact that the clay particles when heating molten punctually touch and consolidated thereby conferring a significant resistant bricks for the compressive strength of a Brick cooked can go generally from 10 to 20 MPa [Pehanich et al., 2004; Mambouana, 2010; Mabiala Bototo, 2012]. The resistance of bricks in the open air were obtained after 28 days. The results of the decrease in the compressive strength of the bricks are in agreement with the work of KHELEFI BELOUATTAR [Khelifi Belouettar, 2012]. This can be explained by the fact that the amount of wood waste contained in the brick created voids or pores thereby reducing the resistance to compression. The low resistance in wood chips is due to the fact that in the clay matrix cement, the chips have a very fibrous appearance as marked channels leading sap confer to these materials in a high porosity and a high rate of dragging voids in the brick which are responsible for the resistance. These values of compressive strengths are well suited to the Australian standard which recognizes that the compressive strength of 2 MPa and the British Standard BS 59211985 which secures a minimum of 5 MPa. Compared to our results we note cement bricks conferred resistance in the incorporation of the mahogany tree waste on the clay brick.

V. Conclusion and Future Work

In this work, wood Chips were built in clay bricks building materials in order to study the effect of environmental temperature on compressive strength. The obtained results shows that the incorporation of mahogany wood chips in the clay brick decrease the compressive strength at air atmosphere temperature. It was found that the compressive strength can be improved with the environment temperature. The advantage using the wood chips is the facilities to collect them easily and can be move easily, the clay materials can be product also locally. The importance of this conclusion is to extend these results to industries applications in order to product local brick mixed to wood chips using clay materials.

The following step of this work will study the relationship between noise pollution as function of wood chips content in order to made brick clay as noise barrier.

References

[1] S. Gaye (2001), "Characterization of Mechanical, Acoustic and Thermal Properties of Local Building Materials in Senegal", *Thesis Status of Science, University Cheikh Anta Diop, Senegal Doctorate*.

[2] L.J. Pehanich, P.R. Blankenhom & M.R. Silsbee (2004), "Wood Fiber Surface Treatment Level Effects on Selected Mechanical Properties of Wood Fiber Cement Composite", *Cement and Concrete Research*, Vol. 34, Pp. 59–65.

[3] P. Meukam (2004), "Characterization of Local Materials for the Thermal Insulation of Buildings, *PhD Thesis, University of Yaoundé 1*,Cameroun.

[4] S. Tamba, M.L. Voumbo, et al., (2007), "Durability of Lightweight Concrete made of Wood Chips", *Journal of Sciences*, Vol. 7, No. 4, Pp. 67–72.

[5] M. Goteicha, N. Khenfer & M. Bederine (2007), "Characterization of Sand Concrete made up of Treated Wood Chips", *National Seminar of Civil Engineering*, Annaba from 20 to 21 November, 2007.

[6] J.V.S. Batékidila (2009), "Mineralogical, Physical and Chemical Study of some Clay Soils Congo: The Case of Mouyondzi, Impfondo and Cuvetteclays", *Master Thesis, Ecole Normale Supérieure / Marien Ngouabi University*, Brazzaville.

[7] J.P. Mambouana (2010), "Study of Flexural and Compressive Strength of Mud Bricks of Talanngaïand Yengola, Stabilized with Cassava Flour and Plastic Waste", *Engineer Dissertation, National Polytechnic College / Marien NGOUABI University*, Brazzaville.

[8] K. Ngoma & B. Poungui (2011), "Effect of Temperature on the Drying Kinetics of Mud Bricks Stabilized with Cassava Flour", *Engineer Dissertation, National Engineering College, Marien NGOUABI University*, Brazzaville.

[9] D. Taoukil et al., (2011), "Mechanical and Water Characterization of a Lighter Concrete with Wood Waste", *International Journal of Solar Technology*, Vol. 43.

[10] G.R. Mabiala Bototo (2012), "Effect of Water Environment on the Change of Mechanical Proprieties of Wood during Drying Process", Master Thesis, University *Marien NGOUABI*, Brazzaville (Congo).

[11] W.R. Khelifi Belouettar (2012), "Influence of the Nature of the Wood Chips on the Physical and Mechanical Properties of Concrete Made from Wood Chips", *Twentieth Meeting of Civil Engineering University*.

[12] G. Ganga (2013), "Impact of Wood Waste on the Mechanical and Acoustic Properties of Stabilized Mud Bricks", *Master Thesis, University of Yaoundé1*, Cameroun.

[13] A. Nzabana (2013), "Study of the Influence of the Content of the Shavings and Sawdust Mahogany Stresses and Strains on the Clay Brick during Drying in the Open Air and in the Oven", *Master Thesis, Marien Ngouabi University, Faculty of Sciences and Technology*, Brazzaville (Congo).

Prof. Timothée Nsongo is currently Scientist at Physics Department (Faculty of Science – University Marien NGOUABI – CONGO Brazzaville) who he is conducted a research program in the research group of physics and mechanical properties of materials and also he is a Director of scientific and information of technology Department at the research center of mining and geology. His current research involves the clay based materials characterization and industrial applications, the nano particles growth, the structure and mechanical properties of alloys for Biomaterials applications.

Gilbert Ganga. He is working as a Lecturer at the University of Marien NGOUABI. He is preparing under the joint direction of Professor Timothée NSONGO and Thomas Tamo TATSIETE a ph.D thesis. Gilbert GANGA has already published one paper and make two oral scientific presentations at the international conference**.** He is an Engineer of mechanical Engineering graduated. He is working as a Lecturer at the University of Marien NGOUABI. He is preparing under the joint direction of Professor Timothée NSONGO and Thomas Tamo TATSIETE a ph.D thesis. Gilbert GANGA has already published one paper and make two oral scientific presentations at the international conference. He is an Engineer of mechanical Engineering graduated.

Prof. Thomas Tamo Tatsiete is a professor at the University of Yaoundé1.He is a Manager Director at the Department of development research for industry at University of Yaoundé. He has directed more of 10 Ph.D and published more of 20 papers. He has a Ph.D in Civil engineering.

Dr. Hilaire Elenga is a lecturer – Assistant at department of Geology of University Marien NGOUABi. He also is a Manager Director of the Research center of Mining and Geology. Dr Hilaire Elenga is the head of the project on clay materials in CONGO. He has published more of 10 papers. He is a Ph.D graduate of university of Marseille.

