ELABORATION OF A MATERIAL USED IN MASONRY BY GEOPOLYMERIZATION OF CLAY SOIL OF TOYOTA ££ LIKASI

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ABSTRACT

Construction materials with less energy at low temperature less greenhouse effects in perspective of respect for Ecology C. BOUTTERIN and J. DAVIDOVITS from an article from the site www.geopolymer.org published in .Actuality of the construction of Earth in France, Plan Construction Ministry of Housing, Paris, 1982. Four Sites of Clay on descent on KAMPEMBA (1), MIVUKA (2) , KIKULA (3), and TOYOTA (4) We are delayed with reactive dissolution - hydrolysis and polycondensation in the solidification of clay soil from TOYOTA to LIKASI for masonry too much use ; The traditional technology of making baked bricks allows cooking between 900 and 1100 ° C.Great energy consumption. The source used for this purpose is wood. which has the consequence progressive deforestation and the emission of carbon dioxide that are at the base of global warming climate. A new technology, Geopolymerization, with local clays we got a stable biomaterial in water, porosity of about 10% and compressive strength of about 200kgf / cm^2 under the following conditions: fraction of caustic soda in the raw mixture: 4%; water of tempering: 12 g per 100 g of the raw mixture; cooking temperature: 150 ° C; compaction load: 0.75 kN (ie 10.61 kgf / cm^2); cooking time: 2.5 hours, economical drinking. The rest of the Article, in thanks from RD Congo **www.leganet.cd** to Decree No. 14/019 of 02 August 2014 setting the rules of Procedural Mechanisms of Environmental Protection Reticulation Geopolymerique "TRIAL OF SYNTHESIS OF GEOPOLYMERS FROM CERTAINESS LOCAL CLAIMS "(Use cases of Na (OH) or K (OH), with adjuvants before polycondensation.

A contribution from Saint-Quentin / FRANCE headquarters of GEOPOLYMERES, the law of MURPHY to a NEWCOMERS: Geopolymers Applications 4th Ed. 2015 and USB VIDEO in hands after training 9TOPICS, and a BONUS in addition to 3% alkalizing reagent, at the results views on bricks **L.T.G.S** '**L**ittle **T**emperature **G**eopolymer **S**etting ', redo the classic sampling to the laboratory at lower temperatures more daily, 65 ° C, 85 ° C, 95 ° C and 105 ° C towards required results from 10MPa to 15MPa practical Moreover, Geopolymer Camp annual daily two invitations of 2017 and 2018 received, also an eye of the website www.groupemodulu.com the book Science and Materials Engineering William D.gallisster, Jr, modulo 2001 in our hands.

Key words: L.T.G.S. bricks TOYOTA.

1. General

The synthesis of silicon-based **polymers** is mainly carried out using raw materials from minerals that form rocks of geological origin, hence the name:**Geopolymers**. Joseph Davidovits has invented the term in 1978 [1] and created the French non-profit scientific institution (Association Loi 1901) Geopolymer Institute (Geopolymer Institute).

An approach of four clay sites from LIKASI in DR Congo to a geopolymerization reaction hydrolysis solution in an alkaline solution NaOH and, or KOH, solidification in an analysis the compressive strength. Use of little energy, very little deforestation, a safeguard of the ecology, of the environment, the rising water of streams, seas, oceans of the planet and the sense of avoiding the global warming.

Applications of Geopolymers in the construction of our habitats and the various infrastructures of our a reasonable cost in the preservation of the environment.

1.1. Terrain works.

Four sites of the city of LIKASI have been targeted namely: KAMPEMBA (1), KIKULA (3), MIVUKA (2) and TOYOTA (4) as shown in (Figure 1).
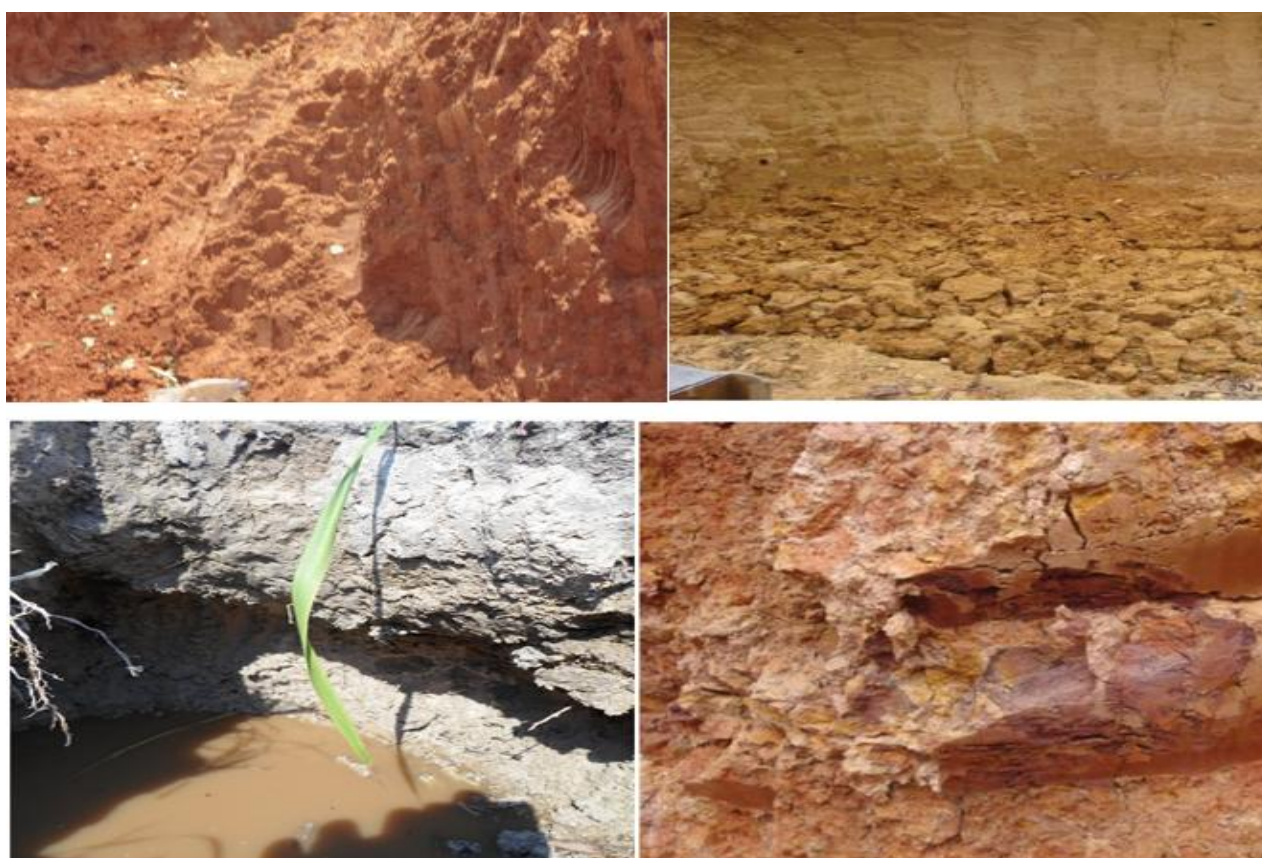

Figure 1: Different clay soil sampling sites

1.Effective fieldwork:
– *Collection of geographical coordinates of each site ,*
– *sampling of clay samples at 4 sites (30 kg / site)).*

  2.materials :
  - GPS
  - hammer,
    - a digital camera,
    - bag of raffia,

- *plastic bags*

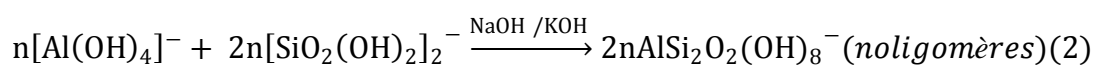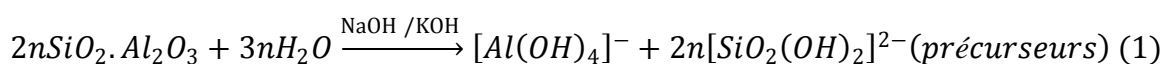**Figure 2: Some materials used for field works**

Pickaxe and shovels the authors privileged on the beginning of the mineral material of TOYOTA very used in the constructions LIKASI City and, to initiate the Geopolymerization approach from where the NaOH reagent and the water of mixing, without adding any adjuvants

1.2. GEOPOLYMERIZATION MECHANISM (GEOSYNTHESIS)

The mechanism of the Geopolymerization reaction is not yet fully elucidated. Work on the process of this reaction is still recent compared to the discovery of Geopolymers, the majority mechanisms initially proposed consisted of two steps: a dissolution of the mineral of aluminosilicate in the activating alkaline solution, followed by a polycondensation leading to a gel amorphous [Xu and Van Deventer, 2000]. more recent studies propose a reaction mechanism according to following three steps [Xiao et al., 2009]:

1. *issolution/hydrolysis* : Geopolymerization begins with hydrolysis of H proton + by monovalent cations (Na^+, K^+)of the alkaline solution, on the surface of the aluminosilicate mineral.Follows the dissolution phase, that is to say the rupture of Si-O-Si and Si-O-Al bonds of the mineral for to form reactive precursors $Si(OH)_4$ et $Al(OH)_4^-$ in the solution. The dissolution is concomitant gelation of the aluminosilicate;

2. *. polymerization*: les monomères $Si(OH)_4$ et $Al(OH)_4^-$ monomers- react with each other to give the oligomers $AlSi_2O_2(OH)_8^-$ Aluminosilicates which condense into a gel ;

3. *.stabilization: the gel formed probably undergoes reorganization to give a large network.*

The process of geopolymerization can be illustrated by the following equations [Rovnanik, 2010] :

$$2nSiO_2.Al_2O_3 + 3nH_2O \xrightarrow{\text{NaOH /KOH}} [Al(OH)_4]^- + 2n[SiO_2(OH)_2]^{2-} (précurseurs) \text{ (1)}$$

$$\text{n}[Al(OH)_4]^- + 2n[SiO_2(OH)_2]_2^- \xrightarrow{\text{NaOH /KOH}} 2nAlSi_2O_2(OH)_8^- (noligomères)\text{(2)}$$

$$2nAlSi_2O_2(OH)_8^- \xrightarrow{\text{NaOH /KOH}} (Na^+, \ K^+)-[AlSi_2O_2(OH)_8^-]_n + 4nH_2O \ (polysialates) \text{ (3)}$$

Work has shown that the reaction of Geopolymerization is faster when the alkaline solution

contains sodium or potassium silicate compared to that containing only the alkaline hydroxide, it is the effect of silicates [Davidovits, 1991].

Dissolutions, reorientations in addition of adjuvants for applications followed by

polycondensation,

gelation are imperious.

1.4. APPLICATIONS
- Constructions

- Civil engineer

Inthe objective of the present work is elaboration of a material usable in Masonry by Geopolymerization ofclay soil of Toyota LikasiInthe objective of the present work is elaboration of a material usable in Masonry by Geopolymerization ofclay soil of Toyota Likasi very used in the traditions of the usual brickworks in the presentenvironments.

2. Introduction

Clay minerals are part of industrial mineral substances. However industrial minerals are minerals and rocks that are economically valuable and different from minerals metal, precious stones or fuels. they can be used, directly or with some treatments, in the industry after their extraction. Minerals and industrial rocks in the strict sense are specific materials (kaolin, feldspar, carbonates, etc.). Used as materials principal substances, these substances include building materials (clays, sands, gravel, aggregates of rocks).

To this end, the site of TOYOTA very exploited in the city of LIKASI was selected for this article. The neighborhood TOYOTA is located in the town of Likasi, at the entrance to the city of Likasi when coming from Lubumbashi, after sampling we defined and retained the temperature and duration of cooking, the water content of mix, the percentage of caustic soda in the raw mix, and the compaction load as parameters leading to the obtaining of a material having mechanical and physicochemical properties sought.

the beauty www.geopolymer.camp of the expectation of this approach as a first touch of this first site Continuing in the conclusion in view of the preliminary draft of a DEA thesis by the planetary Icone the Grand Master Professor Joseph Joseph DAVIDOVITS around 83 years of age creating this word "Geopolymers" in full work already says since 1972, two invitations made to Assistant CHISUNKA philippe at the international Geopolymer Camp July 2017 and July 2018 CICERON says: 'money is the nerve wars', a new world of materials science to conquer the planet, a book and USB Video training received on September 15, 2017, positive pre-projects of appetite coming from

eating in o bricks L.T.G.S, the local production geopolymer reagent and the Ciments'G.P 'Geopolymer sites.

3. MATTER AND METHOD

3. 1. Sampling and Preparation of the material.

Adequate sampling was carried out followed by a preparation which consisted of removing debris from the mother rock, plants and animals as well as organic matter. Delaying is the technique which has been used.

Figure 3: Location of the town of LIKASI and the clay sampling site of TOYOTA

– Soak the clay material in water until it softens to allow disintegrate by hand so as to have a homogeneous suspension.

– Pass the suspension obtained above through the sieve of 0.5 mm mesh to retain, thus,all the particles having the dimension greater than the mesh of the sieve used.

– The passer to this sieve was collected on trays and oven dried as seen in the figure3. This is the product that interests us. Where as rejection is rejection.

Aggregates that have formed during drying must be sprayed to release the particles fine constitutive clay minerals. To get there we used a steamroller for spraying aggregates. itfollowed the homogenization to close this stage. The resulting product is the one that was used for testing and characterization.

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Figure 4: Clay soil after mixing and drying.

3.2.Characterization of clay material.

To confirm the nature of the material taken it was necessary to carry out some analyzes. Which analyzes and the determination of insoluble in different acids.

3.2.1. Analyses chimiques.

They focused on the measurements of the major oxides (SiO_2, Al_2O_3, Fe_2O_3, MgO, CaO, Na_2O, K_2O) and elements miners (Pb, Zn, etc.) contained in the clay loam. The oxides were determined using the methods and minor elements by atomic emission spectrometry and atomic absorption spectrometry.Les résultats obtenus The results obtained are recorded in Tables 1 and 2.

Table 1: Average chemical composition of major oxides of TOYOTA clay.

SiO_2	Al_2O_3	CaO	Na_2O	K_2O	Fe_2O_3	MgO
59.38	27.58	0.08	0.17	0.99	3.37	2.05

Table 2: Percentages in main elements.

Si	Al	Ca	Na	K	Fe	Mg	P	Cd	Ni	Cu	Co	Pb	Zn
27.86	14.84	0.06	0.13	0.82	2.38	1.63	0.39	0.018	0.001	0.03	0.002	0.007	0.003

In most soils of greater Katanga the alumina is in the form of hydrated aluminosilicates. In in other words, it is always bound to silica. In addition to bound silica, there is still free silica. Thus, to testify to the presence of one or more clay minerals in the earth, one refers to the content of alumina. The 27.58% alumina content in Table 1 shows that the sample is rich in minerals clay. The aluminum content in Table 2 confirms the result of Table 1with the exception of sesquioxide iron

and magnesia the other constituents have contents lower than unity. This shows that the sample in our possession has a relatively high degree of purity so as not to hinder the crosslinking.

3.2.2. Determination of insoluble.

The insoluble is the percentage of the residue that remains after the acid attack. Equipment, reagents, products and the procedure used for determining it is given in Annex Iwe represent thep1, the insoluble residue and, INS, the percentage of the insoluble matter.

According to Table 3, in general, the fraction of the aliquot subjected to the test which has been solubilized is relatively low depending on the nature of the acid. It increases with the oxidizing power of the acid. It would be related to the behavior of clay minerals, silica and iron sesquioxide which are refractory to acids used.

Table 3: Percentages of Insoluble Residue in Different Acids.

N°	Acide	P_0 (g)	P_1(g)		INS_1 (%)	INS_2 (%)	INS (%)
			1	2			
1	H_2SO_4	5	4,9	4,9	98	98	98
2	HCl	5	4,8	4,7	96	95	95,5
3	HNO_3	5	4,7	4,7	94	94	94

3.3. EXPERIMENTAL METHOD

The development of a material requires the mastery of a number of parameters related to the path that has been chosen. In most cases, the parameters are always numerous. As far as we are concerned, we chose the most important for crosslinking. it is the composition clay / caustic soda, the mixing water content, cooking temperature, cooking time and compaction load.

The determination of the compressive strength according to these parameters will make it possible to find the optimum, the latter being the most important property of a building material. The first three parameters were studied at the same time. Once the optimum found we went to study the cooking time and finally to the compaction load. after finding the optimum for all parameters, the material obtained under these conditions has been characterized by determining its apparent porosity and its resistance to attack of certain aggressive media whose modes of operation are attached. the equipment, the reagents and the procedures used to carry out the tests intended to gather the data necessary to achieve the objectives are given below.

3.3.1. Material, reagents and products.

a) Hardware

The material used consists of:

- A 100 ml stemmed glass;

- a stainless steel tray for mixing;

- a circulating air APEX dryer;

- 50 and 100 ml Erlenmeyer flasks;

- a 1000 ml flat-bottomed flask;

- a KERN balance of 2000 ± 0.1 g;

- a watch glass 10 cm in diameter;

- a stopwatch;

- 30 ml pvc jars;

- a black marker;

- a M & O hydraulic press from the Road Office laboratory (Figure 5);

- a cylindrical mold 3 cm in diameter composed of a piston, a cylinder, a plug lower and an open mold release cylinder (Figure 4);

- a caliper (Chinese);

- a NABERTHERM electric oven at 1200 ° C (figure 6);

- a brush;

- a spatula;

- a desiccatorfigure 6: Hydraulic press Figure 7: Electric oven

b) Reagents and products

The reagents and products used are as follows:

- caustic soda,

- distilled water,

- SAE 40 engine oil.

Figure 5: Mold for shaping specimens

Figure 6: Hydraulic Press   **Figure 7: Electric oven**

3.4. Operational modes.

a) Elaboration of test pieces.

The shaping of the test pieces (FIG. 8) was carried out as follows, in the case where the reagent Geopolymerizing is caustic soda:

- Weigh 160 g of clay for four test pieces;
- place on the stainless steel tray;
- Using a walking glass, take the required volume of concentrated caustic soda solution

known as shown in Table 4, the quantity of caustic soda and that of water correspond to the percentage of caustic soda and the content of mixing water;

Table 4: Concentration and volume of NaOH solutions used

% and ml of the NaOH solutions used									
Raw mix(%)		Mixing water content (g of water / 100 g of the raw material							
		12		13		14		15	
Clay	NaOH	%	ml	%	ml	%	ml	%	ml
97,50	2,50	17,59	19,48	16,41	21,02	15,57	23,41	14,59	24,92
97,00	3,00	20,52	19,68	19,21	21,24	18,08	23,51	17,09	25,11
96,50	3,50	23,21	19,91	21,82	21,44	20,56	23,72	19,46	25,31
96,00	4,00	25,81	20,18	24,26	21,68	22,97	23,93	21,77	25,52
95,50	4,50	28,14	20,39	26,55	22,64	25,11	24,21	23,85	25,74
95,00	5,00	30,43	20,69	28,76	23,01	27,27	24,53	25,91	25,97

- divide the resulting dough into four pellets of 45.96 g each so as to have test pieces of whichthe diameter and height are equal (EN 196-1 standard);

- place each of the meatballs in a bag, making sure to close it to prevent water loss

and the carbonation of the soda;

- place each of the pellets made in the mold;

- compact with a load required to maintain for 15 minutes;

- then unmolding the test piece;

- dry first at room temperature and then in an oven at a temperature of 60 ° C until

complete elimination of moisture;

- Cool to the desiccator to room temperature and weigh the Po test tube;

- place the series of test pieces in the oven at room temperature;

- start the previously stabilized oven at the cooking temperature;

- allow the time necessary for cooking to pass;

- stop the oven;

- cool in the oven to room temperature;

- place the baked test pieces in the desiccator and weigh P1;

- submit each specimen to the compression test;

- note the breaking load, Pc (kg)

- calculate the compressive strength Rc of each specimen in kgf/cm^2

$$\text{d'après} : \boldsymbol{R_c = \frac{Pc}{S} = \frac{Pc}{\frac{\pi}{4}D^2} = \frac{4Pc}{\pi(3)^2} = 0,14147 Pc} \quad (4)$$

Figure 8: Geopolymer test tubes 'L.T.G.S'.

b) Preparation of NaOH solutions

Knowing the amount of caustic soda involved in the raw mix and the amount of water to use for tempering we calculated the percent concentration of the caustic soda solution at use. According to the table (J.W. Mullin, Perry) concentration expressed as a percentage and in grams per liter of

solution we calculated the amount of soda that was needed to prepare 50 ml of solution. The the volume of the solution to be taken is that containing the quantity of caustic soda to be the raw mixture. This reasoning is the basis of Table 4 above.

c) Characterization of the material

1 ° Determination of apparent porosity: The measurements were carried out according to standard   ASTM C 20 – 74 (ASTM, 1979). We started by determining the mass ms of the specimen that was dried at 105 ° C in an oven to constant weight. then the test piece is immersed in a beaker containing distilled water. The beaker and its contents are boiled for 2 hours. After letting it rest for 24 hours, the test piece is removed from the water and dewatered; its wet mass (mh) is determined. the percentage of water absorption (A) of each test piece is expressed by the relation (6):

$$Abs = \frac{m_h - m_s}{m_s} \times 100 \quad (6)$$

2° Resistance to aggressive media : 100 (6the cycle being one day, after removing the test piece from the solution we dried it in an oven at a temperature of 105 ° C until constant mass. The difference between mass of the test piece before and the mass of the test piece after being reduced to one hundred grams of the mass of the test-tube before immersion in the attacking medium expresses the degree of destruction of the material during the test during the immersion time.

4. PRESENTATION AND ANALYSIS OF RESULTS

The specimens shaped under the conditions described in the previous chapter, were subjected to some tests characterization to determine compressive strength, resistance to certain aggressive media as well as the absorption of water. At the end of these tests we obtained results relating to it. In this chapter, we present and analyze them.

4.1. INFLUENCE OF THE GETTING WATER CONTENT, THE DOSE OF THE REAGENT

Resistance to compression as a function of mixing water content and reagent dose geopolymers are shown in Tables 5, 6, 7 and 8 respectively for cooking temperatures 150, 200, 250 and 300 ° C. The conditions under which they were obtained are as follows:

- Compaction load: 1 kN;
- cooking time: 2 hours 30 minutes.

These same results are illustrated by the curves shown in FIGS. 7, 8, 9 and 10 for the same cooking temperatures.

Table 5: Compressive strengths as a function of percentage of caustic soda and content in mixing water at 150 ° C

Caustic soda[%]	Resistance to compression [kgf/cm^2]			
	mixing water content [%]			
	12	13	14	15
2,5	127,32	110,35	84,88	67,91
3,0	155,62	105,39	110,35	84,88
3,5	189,57	138,64	169,47	87,71
4,0	200,89	161,28	175,42	110,35
4,5	198,06	178,25	186,74	118,83
5,0	203,72	180,59	200,38	130,16

Table 6: Compressive strengths as a function of percentage of caustic soda and content in mixing water at 200 ° C

Caustic soda[%]	Resistance to compression [kgf/cm^2]			
	mixing water content [%]			
	12	13	14	15
2,5	220,69	203,72	161,28	155,62
3,0	232,01	209,76	220,69	178,25
3,5	243,33	226,35	220,30	195,23
4,0	260,30	248,99	251,82	235,67
4,5	268,79	280,11	280,11	239,50
5,0	291,43	280,62	319,72	240,67

Table 7: Compressive strengths as a function of percentage of caustic soda and content in mixing water at 250 ° C

Caustic soda[%]	Resistance to compression [kgf/cm^2]			
	mixing water content [%]			
	12	13	14	15
2,5	251,82	223,52	220,69	181,08
3,0	288,60	251,82	246,16	183,08
3,5	348,02	277,28	280,11	200,89
4,0	336,89	297,09	305,58	206,55
4,5	339,53	308,40	308,40	232,01
5,0	348,02	305,58	333,87	308,04

Table 8: Compressive strengths as a function of percentage of caustic soda and content in mixing water at 300 ° C

Caustic soda[%]	Resistance to compression [kgf/cm^2]			
	mixing water content [%]			
	12	13	14	15
2,5	319,72	263,13	243,33	277,28
3,0	333,87	291,43	280,11	322,55
3,5	359,33	328,21	302,75	331,04
4,0	381,97	345,19	271,62	333,87
4,5	407,43	387,63	305,58	404,75
5,0	475,34	418,75	319,72	444,22
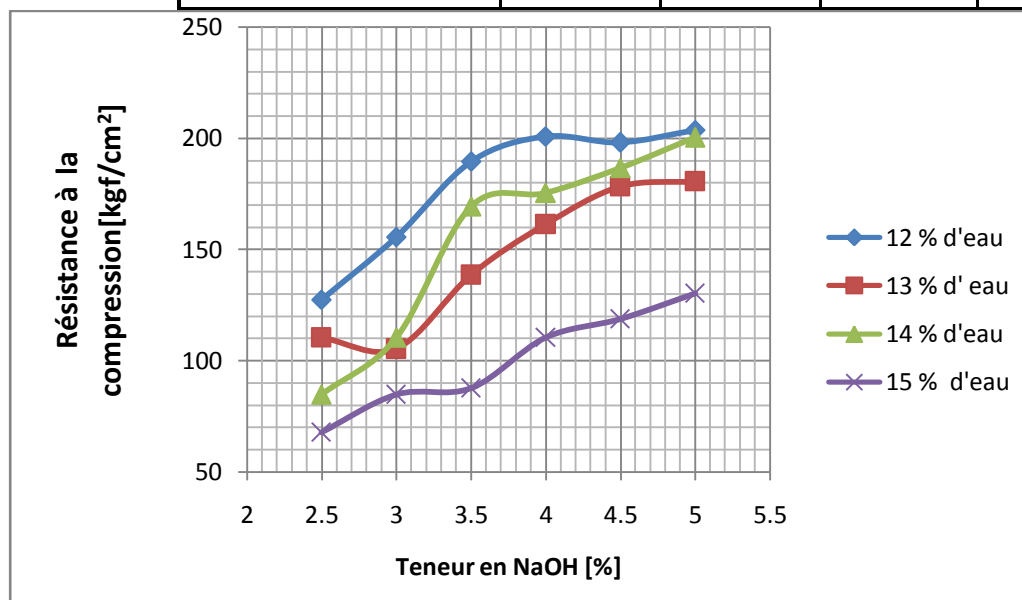
Figure 9: Resistance to compression as a percentage of NaOH at 150 ° C

By examining Figure 9 deduced from Tables 5, 6, 7 and 8, the following emerges. Resistance to compression increases, in general, according to the percentage of caustic soda except for the curverelating to 12% of mixing water which; from 4% soda, tends to stabilize. When the content . In tempering water the curves are moving downwards with a few exceptions. This translatesby a decrease in the mechanical properties of the material.

According to the literature (Banza M., 2013/Polytthechnic classic), at less than 12% of water, we have a dry paste that does not lend itself betterto compaction because the grains slip with difficulty due to lack of enough lubricant while at more than 13%,the amount of mixing water becomes important so that during compaction, it is expelled, leaving.
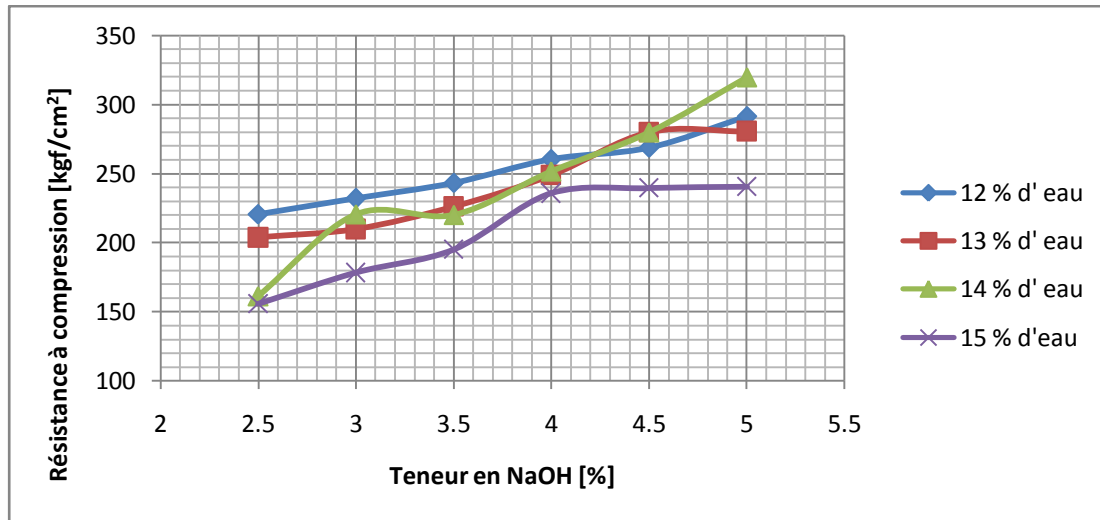
Figure 10: Resistance to compression as a percentage of NaOH at 200 ° C

15% water the plateau was reached for a percentage of caustic soda of 4%.

From Figure 10 referring to the temperature of 200 ° C, the compressive strength as a function of percentage of caustic soda for different contents of mixing water remains increasing. Except of the 14% water curve which is monotonous until reaching compressive strengths relatively high order of 319.7 kgf / cm^2 at 5% caustic soda, the curves for 12, 13 and 15% of mixing water show a plateau from 4% caustic soda. Moving curves depending on the tempering water content down is not as remarkable as in the case previous. the compressive strengths have been improved anyway and the good pace is that relating tothe mixing water content of 12%.
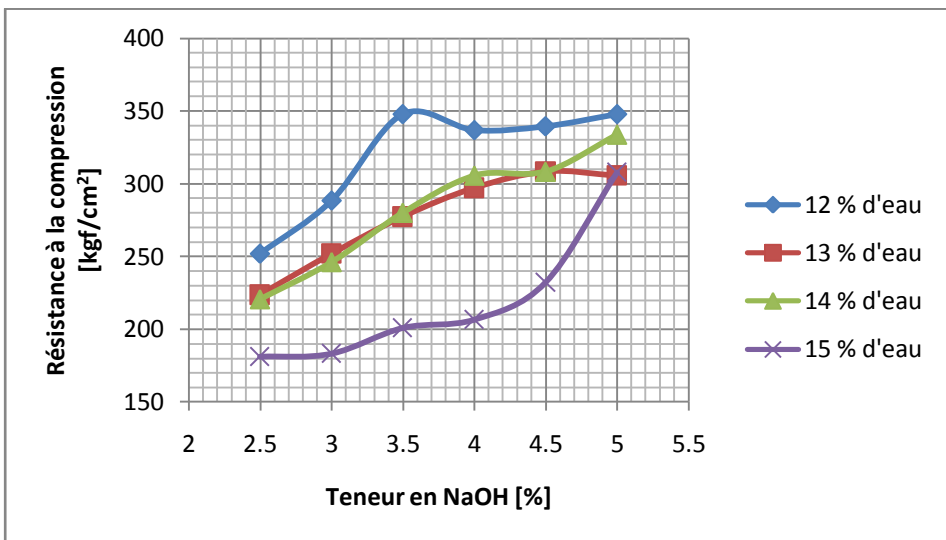

Figure 11: Resistance to compression as a percentage of NaOH at 250 ° C

According to Figure 11 referring to the temperature of 250 ° C, the curves relating to 13 and 14% of water of temptation grow together. The curve corresponding to 12% of mixing water grows very quickly between 2.5 and 3.5% caustic soda to reach a plateau with a caustic content of about 3.5%

348.0 kgf / cm2 .As for the curve relating to 15% of mixing water, it deviates from the others despite his growth. it has low resistances compared to other curves.

As for FIGS. 9 and 10, it is the curve relating to 12% of mixing water that presents the resistances the highest compression from the mixing water content of 3.5%.
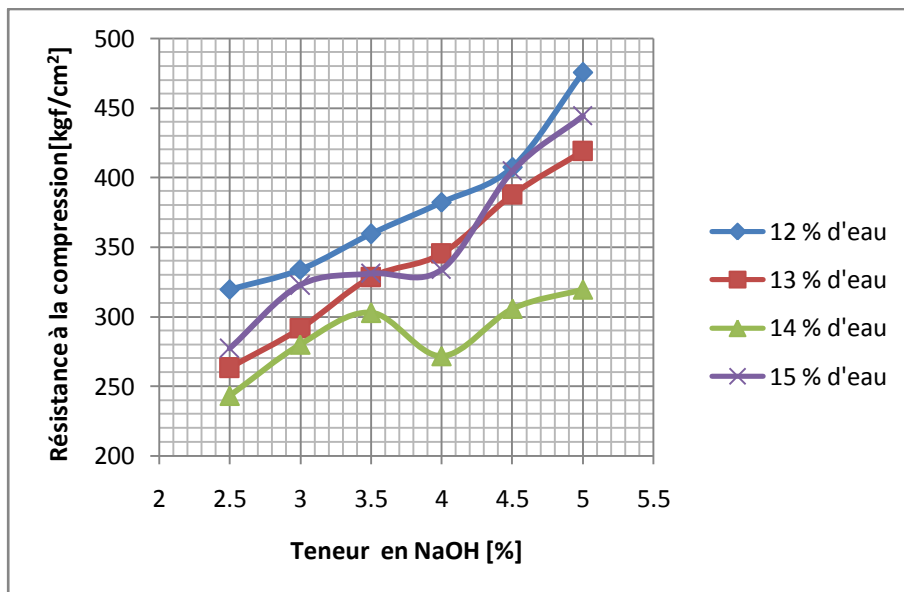

Figure 1 : Resistance to compression as a percentage of NaOH at 300 ° C

Examination of Figure 12 reveals that the compressive strength increases as a function of the sodium content for the different contents of mixing water. unlike previous curves, which had a plateau around 4% caustic soda, they are monotonous.

15% waterunlike the previous curves, which had a level around 4% in caustic soda, as says these are monotonous.The curves move downwards as the content of mixing water increases as was the case on Figures 9, 10 and 11.the curves here are even closer together with the exception of those yielding 14% of mixing water which tends to stabilize from 3.5% caustic soda.

In the light of the foregoing, we can already retain the 12% mixing water content which has givengood resistance to compression. It will now be necessary to stop the temperature and the content of caustic soda.

This is the reason why we represent in Figure 13 the curves of the compressive strength according to the caustic soda content for each of the cooking temperatures for the water contenttempering of 12%.

Table 9: Resistance to compression as a function of cooking temperature

Temperature [°C]	Resistance to compression [kgf/cm^2]					
	2,5 %	3 %	3,5 %	4 %	4,5 %	5 %
150	127,32	155,62	189,57	200,89	198,06	203,72
200	220,69	232,01	243,33	260,30	268,79	291,43
250	251,82	288,60	348,02	336,89	339,53	348,02
300	319,72	333,87	359,33	381,97	407,43	475,34
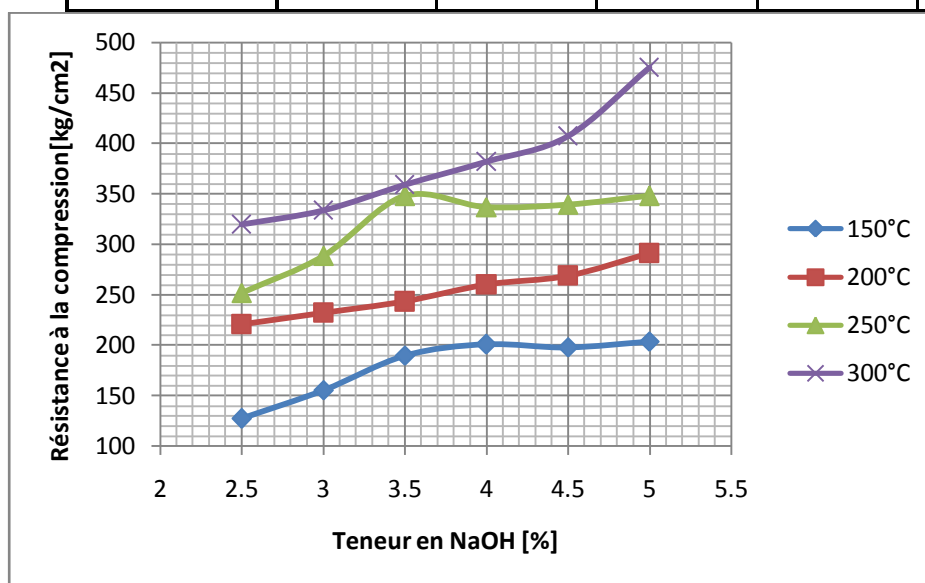
Figure 13: Resistance to compression as a function of the caustic soda content at different cooking temperatures at 12% mixing water

by analyzing FIG. 13, we notice that the compressive strength which is an increasing function of the percentage of caustic soda is also an increasing function of the cooking temperature. The curves move upward as the temperature increases. 300 ° the percentage of caustic soda is also an increasing function of the cooking temperature. The curves move upwards when the temperature increases. In general, the bearing is observed from 3.5% caustic soda depending on the temperature of cooking except for that of 300 ° C which is monotonous. The curve increases substantially until reaching the highest value of about 475.3 kgf / cm2 corresponding to the percentage of sodium hydroxide of 5%.

The reason for this is that the kinetics would have become very weak until the reaction reached the balance. In this case the polymerization reaction is incomplete. The passage of the temperature from 150 to 300 ° C improved the kinetics of this reaction. as a result, the polymerization intensifies,

resulting in increasing the degree of crosslinking. This results from the passage of the hydrated aluminosilicate from the crystalline amorphous phase likely to react easily.

From what precedes we retain that for the same cooking temperature and the same water content the compressive strength increases as the percentage of caustic soda increases while for an increasing mixing water content, the compressive strength is a function decreasing.

The highest values of mechanical strength were obtained at 12% of mixing water depending on the percentage of caustic soda for different temperatures. from 4% caustic soda variations in compressive strength are relatively small except for the curve for cooking temperature of 300 ° C. We selected the mixing water content of 12% and the percentage in caustic soda of 4%. we opted for the temperature of 150 ° C, yet having given the lowest compressive strengths. This is for a minimal energy expenditure and a low production of greenhouse gases, the properties can be improved by changing the cooking time.

4..2. INFLUENCE OF COOKING TIME

Table 10 shows the values of the compressive strength of three tests performed at different cooking times under the following conditions:

- Compaction load:
- Mixing water content ;
- NaOH content: 4%;
- Cooking temperature: 150 °

The average values of these resistances as a function of the cooking time are shown in figure 14.

Table 10: Compressive strength values obtained at different cooking times.

Trial	Resistance to compression [kgf/cm^2] for			
	2,5 h	3,5 h	4,5 h	5,5 h
1	201,72	210,08	210,79	210,79
2	200,30	209,38	210,79	212,21
3	200,89	209,38	210,08	212,21
Average	**200,97**	**209,61**	**210,55**	**211,73**

Figure 2 : Compressive strength values evolution after cooking time.
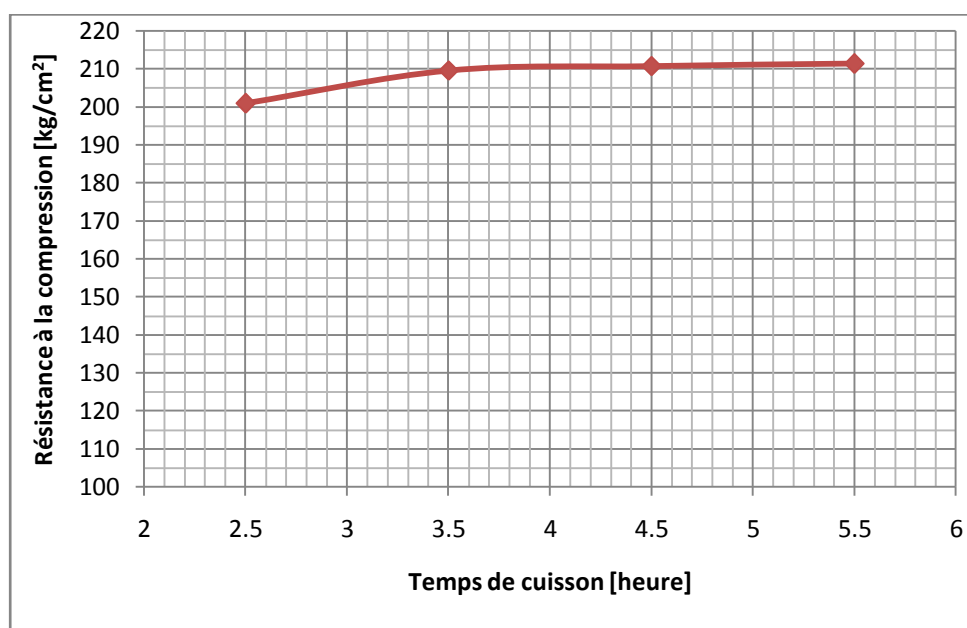
The compressive strength increases first very rapidly, between 2.5 and 3.5 hours, Average 200.97 ; 209.61 ; 210.55 and 211.7 Kgf / cm^2 according to Figure 4 the compressive strength increases first very rapidly, between 2.5 and 3.5 hours, and there after it tends to stabilize up to 5.5 hours. The behavior of the curve between 2.5 and 3.5 hours would be explained by the continuation of the Geopolymeric reticulation. Between 3.5 and 5.5 hours of cooking, the bearing marks the end of the geopolymerization reaction. Compared with the previous results there was a improvement of the values of the compressive strength. they went from 200.97 Kgf / cm^2 at two o'clock and half cooking while between 3.5 and 5.5 hours it varies only a little from 209.61 to 211.73 Kgf / cm2. Enter 200.97 Kgf / cm^2 and on average 211 Kgf / cm^2 the difference is only about 10 kgf / cm^2. This gain is almost insignificant for a relatively large energy consumption. We think, to that end, that it would be therefore reasonable to limit the cooking time to 2.5 hours.

4.3. INFLUENCE OF THE COMPACTION LOAD

We present in Table 11 the compressive strength as a function of the compaction load for test pieces obtained under the following conditions:

- Mixing water content: 12%;
- NaOH content: 4%;
- Cooking temperature: 150 ° C;
- Cooking time: 2.5 hours.

Table 1 : Table 11: Compressive Strength vs. Compaction load.

Compaction load[KN]	Compressive strength [kgf/cm^2]
0,25	136,64
0,5	168,00
0,75	200,51
1	200,89

Figure 3 : évolution de la résistance à la compression en fonction de la charge de compactage.
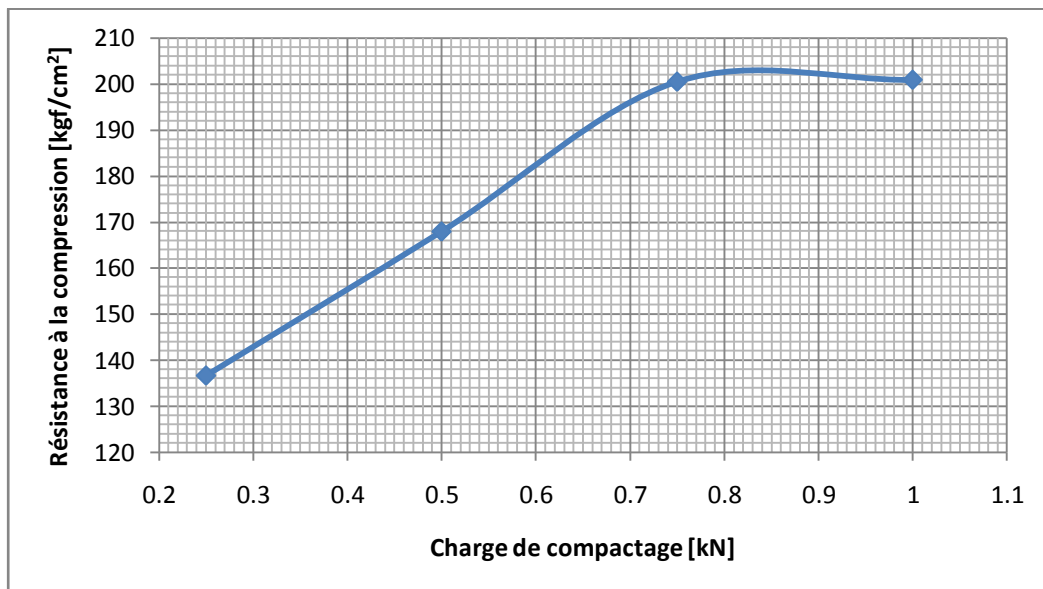
Cooking time [hour]compressive strength is quite increasing at as the compaction load increases. Between 0.25 and 0.75 kN; compressive strength increases linearly as a function of the compaction load. From 0.75 kN up to 1 kN, the curve tends to stabilize. the value of the compressive strength increases from 200.51 to 200.88 Kgf / cm^2.The difference is really insignificant. Increasing the compaction load requires energy. The expense energy is less at 0.75 kN than at 1 kN for almost the same compressive strength. in that case, we retained the compaction load of 0.75 kN. From this compaction load the texture was stabilized. In other words, it can no longer be influenced by the compaction load if it is increased.

4.4. CHARACTERIZATION OF THE MATERIAL

4.4.1. Apparent porosity

the average of the results of the water absorption tests carried out on three test pieces developed in the optimal conditions is shown in Table 12. In this table ms and mh represent the mase before and after immersion in water. the apparent porosity (Abs) of the material re by the average value of 10.05%. According to the literature of classical works of the Chemical Engineering Laboratories of the Polytechnic Faculty the porosity of a good fired brick is low. It is between 10 and 13%. our material therefore meets the quality that is needed for construction.

Table 2: Average Absorption Value.

N° test	m_s (g)	m_h (g)	Abs (%)
1	40,6	44,8	10,34
2	40,4	44,5	10,15
3	40,4	44,3	9,65
Average			**10,05**

4.4.2. Resistance to aggressive media.

The immersion of the specimens in the media shown in Table 13 allowed us to obtain the percentages of mass losses of the specimens as a function of the immersion time in each of the media. The curves of Figure 16 shows the same results.

Table 3: Mass losses as a function of immersion time in different media

Acid in solution	Mass loss [%]during the following days				
	0	1	2	4	6
0%	0	0,02	0,05	0,05	0,12
1%	0	0,32	0,83	0,84	0,88
2%	0	1,61	1,82	1,89	1,94

Figure 16: Loss of mass as a function of the immersion time for each medium
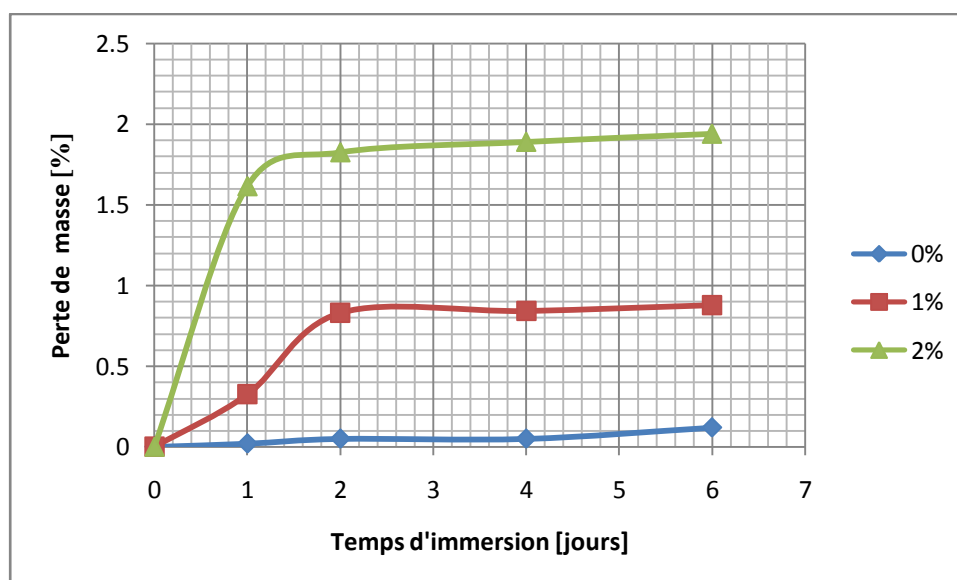
Compaction load [kNis the same for all environments put to the test. From 0 to 2 days of immersion, whatever the environment, the pace of the curve is increasing. Between 2 and 6 days of immersion, there is stability of the percentage of mass loss test pieces. when the aggressiveness of

the medium increases, the bearing moves upwards. In the solution at 0% sulfuric acid the ceiling is reached at about 0.1% loss of material. In the 1% solution sulfuric acid the ceiling is reached at about 0.9% loss of material. finally, in the 2% solution sulfuric acid, the ceiling is reached at about 1.9% loss of material. Curve stabilization shows that after attacking the test tube during the first two days there is no longer free acid capable to react with matter. it is essentially free caustic soda which is neutralized by the acid. This explains why losses are very low, or even negligible, in water. The material developed is therefore stable in water but is attacked by slightly acidic media. This that we must fear are the repeated attacks by these solutions. So, our material will be suitable for buildings for domestic use.

5.CONCLUSION

The use of wood for energy production is at the root of global warming because of the excessive production of carbon dioxide, greenhouse gas, and desertification. Following this threat, the man is called to imagine very energy-saving technologies. One of them is geopolymerization of clay soils at relatively low temperatures compared to those used for sintering of terracotta. At the end of our study, we obtained a stable biomaterial with regard to water with a porosity apparent about 10% and a compressive strength of about 200 kgf / cm2 based on clay soil collected at **TOYOTA** district in Likasi in the Province of Upper Katanga diluted in water, dried and pulverized.

The conditions under which it was synthesized are as follows:

Fraction of caustic soda in the raw mixture: 4%;

mixing water: 12 g per 100 g of the raw mixture;

cooking temperature: 150 ° C;

compaction load: 0.75 kN (10.61 Kgf / cm^2);

cooking time: 2.5 hours.

Other similar studies are to be considered with other clay soils. There is a whole panoply of which the geopolymer reagent behavior depends on the mineralogical composition and the composition chemical. these studies could always be supplemented by a preliminary draft of the production plant of geopolymer bricks L.T.G.S, geopolymer cement 'GP' around '140MPa - 150MPa' with good results that Portland Cement 'PC' in vicissitudes around 20 MPa and 40 MPa - 50 MPa, at the same quantity of production a 90% reduction of CO2 GP Cements do. In safeguard of the environment anby examining the curves in Figure 16, the following observations can be made. The shape of the curves is the same for all environments put to the test. From 0 to 2 days of immersion, whatever the environment, the pace of the curve is increasing. between 2 and 6 days of immersion, there is stability of the percentage of mass loss test pieces. When the aggressiveness of the medium increases, the bearing moves upwards. In the solution at 0% sulfuric acid the ceiling is reached at

about 0.1% loss of material. in the 1% solution sulfuric acid the ceiling is reached at about 0.9% loss of material. Finally, in the 2% solution sulfuric acid, the ceiling is reached at about 1.9% loss of material. Curve stabilization shows that after attacking the test tube during the first two days there is no longer free acid capable to react with matter. It is essentially free caustic soda which is neutralized by the acid. this explains why the losses are very low, even negligible, in the water.

The material developed is therefore stable in water but is attacked by slightly acidic media. This that we must fear are the repeated attacks by these solutions. therefore, our material will be suitable for buildings for domestic use, at the same quantity of production a 90% reduction of CO_2 GP Cements do. in safeguarding the environment and in 2016 and COP 23 of 2017 in Germany, COP24 in Poland towards COP25 trend in Brazil with AMAZONE on first green in 2019 for applications meaning preservation of the planet's climatic balance.The first international meeting 'GEOPOLYMERES' in 1988 and second in 1999, 2002 and 2005 to once a year at the daily Geopolymer Camp invitations. Invitations received in 2017 and 2018 receivedA ssistant CHISUNKA polytechnic UNILU a Newcomer Geopolymer student.

The conquest of the planet in the world of materials science, Cement GP the patent USA No4 509 985received in 1972 since 1972 from Joseph DAVIDOVITS.

Geopolymers statistics figures in progressive GP Cement China from 40million in 1975 to 800 million in 2005 number 1, India a good bridge from 40million to 110 million in 2005, the US to 50million and Italy 30million almost equivalent in 2005. Africa is weak.

Five known GEOASH houses and cited programs and institutions:

> - Coord-geopolymer at Saint Quentin in France.
> - Scientific Institute of Public Service 'ISSEP' in Belgium.
> - 2 seats in Spain (Barcelona and Seville.
> - 1 seat in Delft University of Technology TU deft.

We plan to pursue further raw materials: Clays of always the four sites of LIKASI to relocate geographically by GPS not made in the laboratory after the field and, to continue also with KALUBWE clays, KALAVIONDO by which we made 'Test adobe or adobe bricks'. a classic sampling in standards in projection seen from the notes of the Seminar of Prof. Philippe ANCIA. Advanced Studies in DEA with a 2017-2018 theme: "SYNTHESIS GEOPOLYMERS FROM CERTAIN LOCAL CLAYS. Use case (NaOH, of KOH), and LTGS RETICULATION. (Clays LUBUMBASHI (2) AND (4) LIKASI) (Same) Raw materials: Clays.

Clays-Adobes bricks or rammed an Article then, Bricks -LTGS this Article to GEOPOLY * KNA (4%Na (OH), K (OH)) received on 15 September 2017 a contribution from Saint-Quentin / FRANCE headquarters ofGEOPOLYMERES, the law of Murphy one newcomers: Geopolymers

Applications 4th Ed. In 2015 and USB VIDEO in hands after training 9TOPICS, a BONUS and more is the conference on this Bricks LTGS to VERONA 4th July 2008 FORUM 1th International CERAMIC and BROTHERWOOD. Alkaline solutions of (Na (OH) or K (OH)) GEOPOLY * KNA (3% Na (OH) or K (OH)) of Prof. Doc Joseph DAVIDOVITS the planetary Icone of this creator of this word we will proceed as follows:

- Descent on sampling ground;

- conditioning raw material clays;

- geopolymerization Ceramic Binder: Addition GEOPOLY * KNA (3% Na (OH), K (OH));

- dissolution in the reagent -Reorientation - Solidification;

- reorientation is the addition additives cements and sands;

- daily then 65 ^{0}C, 85^{0}C, 95^{0}C, 105^{0}C above and after 3 days, 15 days, 45 days; and therespective immersions 4 days in water and acid approach;

- point 2 above and Add Lime at 97 ^{0}C;

- point 2 above Addition Asphalt;

-

Measurement of the mechanical resistance with the compression, prediction of the results besides 10 to 15 MPa. Less energy-intensive, avoiding in addition to strengthening the greenhouse effect, deforestation and pollution of the environment, in a good operating cost in industrial briquettes. 6 clay sites in continuation as aroused.

In gratitude to the Government of DR Congo for its gesture towards Decree No. 14/019 of 02 August 2014 laying down the operating rules of the procedural mechanisms for the protection of the environment "geopolymère ".

A work in continuation vs Portfolio Communication to the days mixed scientific Polytechnic-Sciences-ESI of June 28, 2018 and June 29, 2018 made by the Assistant CHISUNKA and an article in one of the publications of these days ; To a DEA of EOPOLYMERES OF SYNTHESIS OF G EOPOLYMERS FROMLOCAL ARGILES. Use case of (NaOH, KOH), L.T.G.S crosslinking on Articles and www.geopolymer.org.Good results obtained with kaolinitic clay for **3% Na$_2$O** of the results of the compression and Geopolymerization treatment temperatures, LTGS bricks laterite materials to the temperature of 70 ° C easy to get zero energy, for 85 ° C between 12 MPa to 18 MPa from 2 to 5% of reagents vs with 3% Na$_2$O reagent:

T^{o}C Temperatures (25°, 60°, 85°, 250°, 450°, 600°, 700° , 1000°)

→ Treated Re (7, 8, **14**, 25, 33, 34, 25, 38) **MPa** to T^{o}C above.

As said after that of 2017 a second invitation made me to the GEOPOLYMER CAMP 2018 the Dean of research Polytechnic UNILU to the Rector done to the Administrative Secretary entrusted. To the sites and Local production of Geopolymer reagent. Meaning COUT.KIVU VOLCAN like in TANZANIA and KENYA.

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