International Journal of Research in Social Sciences
Vol. 11 Issue 03, March 2021
ISSN: 2249-2496 Impact Factor: 7.081
Journal Homepage: http://www.ijmra.us, Email: editorijmie@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gate as well as in Cabell's Directories of Publishing Opportunities, U.S.A

# UPGRADING OF LATERITE FROM LUBUMBASHI FOR USE IN THE MANUFACTURE OF POZZOLANIC CEMENT - CASE OF THE DEPOSIT AT THE UNIVERSITY OF LUBUMBASHI CAMPUS.

***P.ILUNGA MWANZA. , Ph. CHISUNKAKAMPOLOBWE, A. ILUNGA NDALA***
PolytechnicFaculty of the University of Lubumbashi (UNILU) in the Republic

## 0.ABSTRACT

Lateritewhoseheattreatment, Rawmaterials,Methods,Resultsthispenbetween 700 and 800 $^{o}$C, gave itpozzolanicity tests which have consisted of .The determination of the lime fixed by the firedlaterite as a function of the grain size wouldbe the pozzolanic power the durability of possible to obtain a pozzolanfrom the laterite of the universitycampuses of Lubumbashi by heattreatment capable of fixing 739.9 mg of lime per g of pozzolan :you have to heat the laterite at 785 ° C for 4 hours to getitapproximatively 15MPa in the quotes of the Co-authors the same in hunting of zeoenergy adobe bricks and the LTGS bricks 3% (Na(OH),KOH) article 15MPa the greenhouseeffecttowards the CementGeopolymer alkali activation Fly ash and naturalpozzolan basiswith few (NaOH,KOH) 60 $^{o}$CEnvironmentallyFriendlygreen house.

**Key words**: pozzolaniccement, laterite, university campuses of Lubumbashi, Cement Geopolymer, Fly Ash, Natural Pozolan.

## 1. INTRODUCTION

In the midst of the reconstruction period of our country, the manufacture of a lessexpensive binder becomes a major concern for public authorities as well as for researchers. .itismainlymanufactured in our country from portland cement, the cost of production of which has caused the closure of mostcementfactoriestoreducethiscost, wethoughtthatitwas possible to replace a fraction of the clinker withanothermineralmaterial in the formulation of the cementwhichwouldbelessexpensive to obtainfor thispurpose, weopted for lateritewhoseheattreatment, between 700 and 800 $^{o}$C, wouldgiveitpozzolanic power. Its addition to the cementwouldimproveboth the mechanicalresistance and the durability of the mortars vis-à-vis acidicenvironments.

It willbe, therefore, in ourpresentation of

l) Show thatitis possible to prepare a pozzolanicmaterialfrom the laterite of the campus of the University of Lubumbashi ;

2) find the suitable formula for the pozzolaniccementbased on the latter ;

**3) know, finally, up to whatpercentage of acid the mortarbased on ourcementcanresist.**

In cogitation of a before -projectcloselyrelated AAFA Alkali activation on basis of Fly ash and Natural Pozolan the same, .flyflyashfromclays at 60$^{o}$C management of the granulometryclay local ThesisCementGeopolymer citations progress on the roadster ;

4)Reagent local to volcanicspace as TANZANIA , KENYA similar Province KIVU to see.

**2. 2. RAW MATERIALS**

The rawmaterialjustifying the subject of thisstudyislateritefrom the Cities of the University of Lubumbashi. .itwastakennear the Faculty of Medicinewhose.

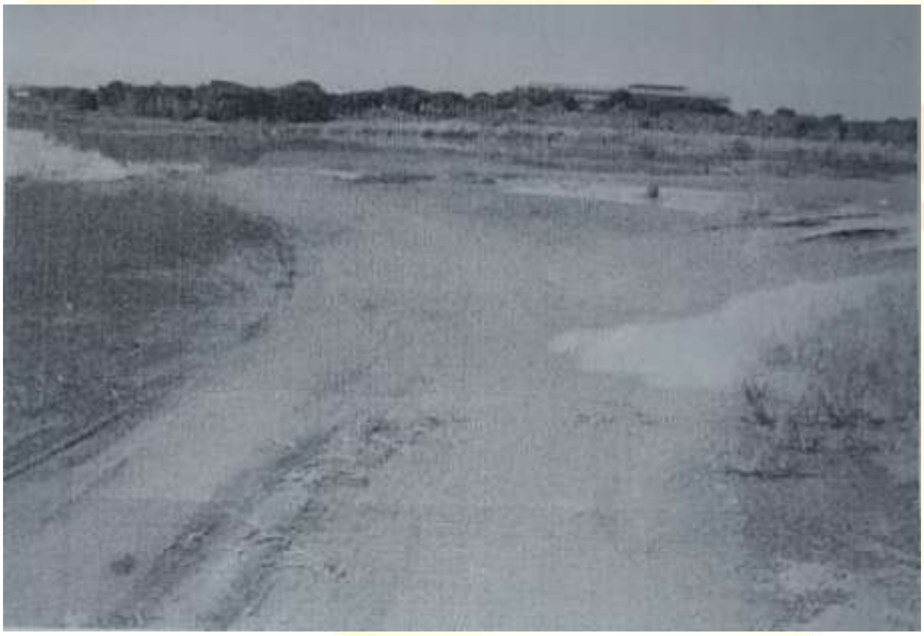

**Figure I : Shot of the lateritesampling site**

The otherrawmaterials are clinker and gypsum. Theyweresupplied by the Lukalacement plant, CIW, Bas-Congo.

The chemicalanalyzeswhichwerecarried out on thesematerials gave the resultsshown in Tables 1, 2 and 3.

**Table 1: Major constituents of laterite**

| Materials | PF | Ins | Si02 | A1203 | Fe203 | CaO | Mgo | S03 | CaOL |
|---|---|---|---|---|---|---|---|---|---|
| Clinker | 0,20 | 0,18 | 21 ,44 | 6,05 | 4,29 | 65,46 | 0,29 | 2,06 | 0,44 |
| | | | | | | 02 | | | |

| Costituant | Fe203 | cao | Mgo | MnO | Na20 | 1<20 | Ti02 | Si02 | A1203 | PF |
|---|---|---|---|---|---|---|---|---|---|---|
| Content (%) | 40,35 | 0,3 | 0,50 | 0,04 | 0,02 | 0,03 | 0,03 | 43, 3 | 11,4 | 3,1 |

**table 2: Minor elements of laterite**

| Eléments | Cu | Ni | Zn | Co |
|---|---|---|---|---|
| Content(%) | 0,02 | 0,05 | 0,05 | 0 02 |

**Chemical compositions, in weight percent, of clinker and gypsum**

***3. METIIODS***

As alreadymentioned in the introduction, the studywascarried out in threestages,the first wasdevoted to pozzolanicity tests whichconsisted in determining the lime fixed by the firedlaterite as a function of the grain size, the temperature and the firingtime,the lime-fixing capacitywasdeterminedusing the Chapelle test, the assembly of whichisshwon in figure 2.

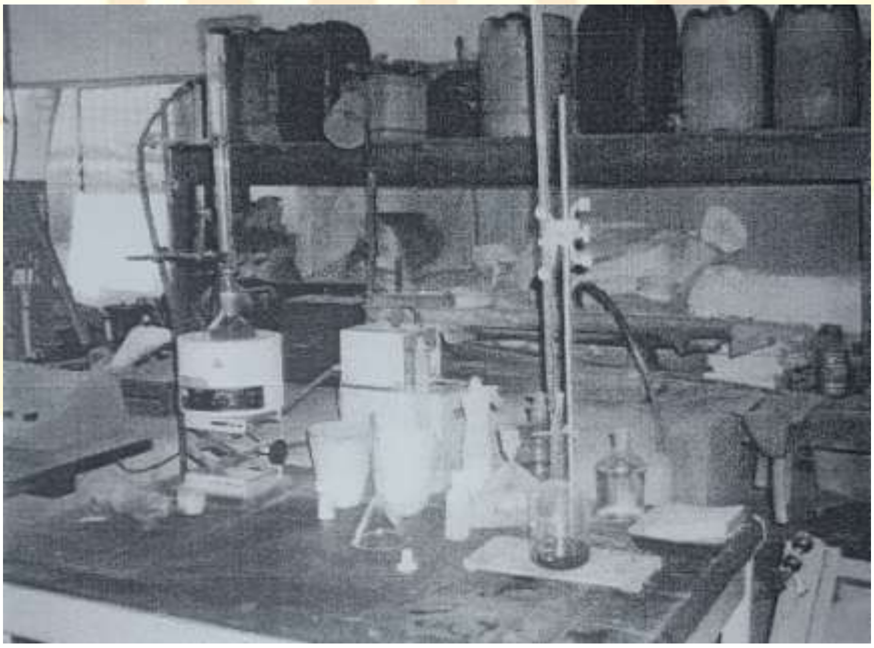

**Figure 2 : Chapel test setup.**

The second wasdevoted to the formulation of pozzolaniccement. .whilekeeping the gypsum content at 5%, wevaried the pozzolan content from 0 to 60% as shown in Table 4.

**Table 4: Pozzolan-clinker-gypsum proportions**

| NO | Mixture | Pozzolan (%) | Clinker (%) | Gypsum(%) |
|---|---|---|---|---|
| 1 | M1 | 60 | 35 | 5 |
| 2 | M2 | 50 | 45 | 5 |
| 3 | M3 | 40 | 55 | 5 |
| 4 | M4 | 30 | 65 | 5 |
| 5 | M5 | 20 | 75 | 5 |
| 6 | M6 | oo | 95 | 5 |

GC separately, weprepared the mortars at the rate of one part pozzolaniccement to three parts of standard sand and half part of water sothat the ratio E 0.50. Thesemortarswereused for the preparation of standardizedcubic test pieces of side b 50 mm using the moldsshown in Figure 3 after 24 hours, the test pieceswereimmediatelysoaked in water (Figure 4) until the time of submission to the rupture tests scheduled at 7, 14 and 28 days of age. The breakingload Pc wasdeterminedusing the pressshown in Figure 5we have finally, calculated the compressive strength RC, in MPa, by the following relation :

$$Rc = \frac{P_c}{b^2}$$

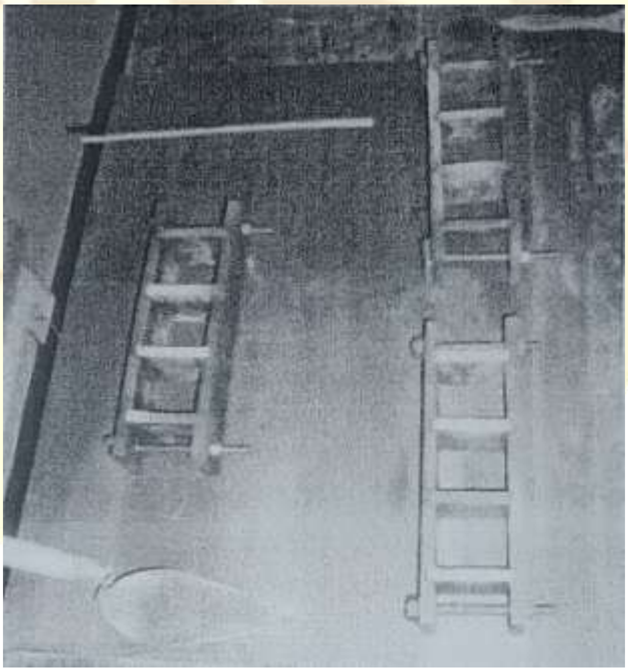

**Figure 3: Mold for shapingspecimens**

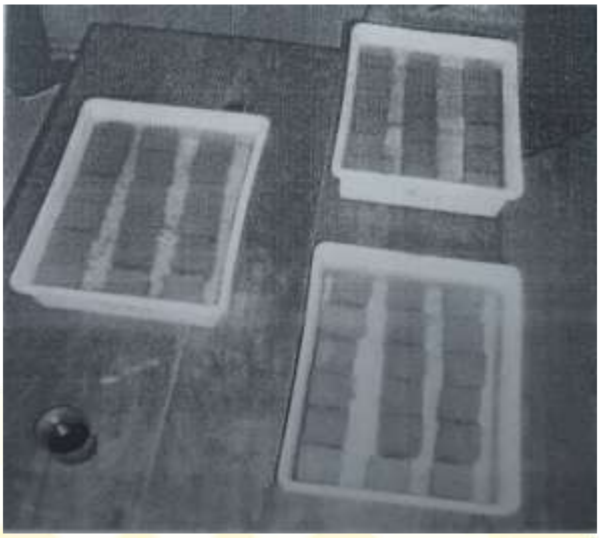

**Figure 4 : Immersion of the test pieces in water**

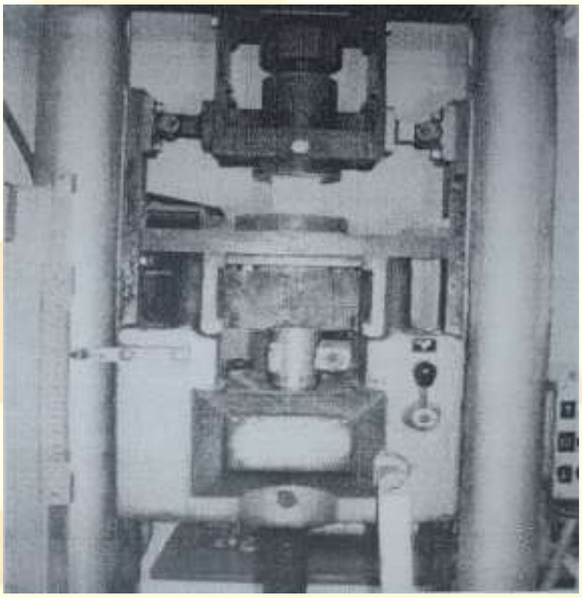

**Figure 5 : Press for determining the breakingload Pc**

The third was devoted to tests againstacidattacks. Whatever the composition of the cement, all the test piecesweresubjected to attack by solutions of sulfuricacid at 3 and 5% according to the standards ASTM 267-96, the test pieces are cleanedthree times withfresh water to remove the weatheredmortar and thenallowed to dry for 30 minutes. Then the weighingiscarried out at 0, 7, 14 and 24 days of immersion.

the degree of attackisevaluated by the loss of mass, in weight percent, expressed by the following relation

$$\Delta m = [(m_1 - m_2)/m_1] * 100$$

With $m_1$, the mass of the test piecebefore immersion and $rn_2$, the mass of the test pieceafter immersion.

## 4. RESULTS

### 4.1. POUZZOLANICITY TESTS OF LATERITY

#### 4. 1.1. Influence of grain size

Experimental conditions :

- Cooking time: 4 hours.
- Particle size: 25.67; 57, 13 and 80.78% passersthrough a 74 htm sieveobtained by grinding the lateritereduced to particle size lessthan 2 mm for 0, 20 and 50 minutes

The resultsobtainedunderthese conditions are shown in figure 6.

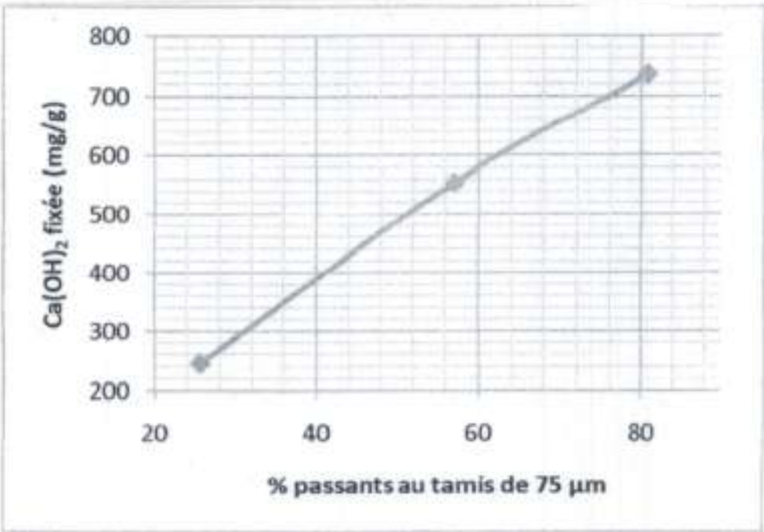


**Figure 6: Influence of the fineness of the particles on the pozzolanicity of the laterite**

**Examination of Figure 6 revealsthat the fineness of the lateriteparticlesconsiderablyimprovespozzolanicity. .weretained, for thispurpose, 80.78% of passers-by through a 74 kimsievecorresponding to 735.903 mg of lime fixed per gram of firedlaterite.**

**4.1.2. 4.1.2. Influence of the cooking temperature**

**Experimental conditions**

**Cooking temperature: 700, 750, 800, 850 et 900 °C.**

-Cooking time: 4 hours.

-Particle size: 80.78% passersthrough a 74 kimsieveobtained by grinding the laterite for 50 minutes reduced to a particle size of lessthan 2 mm The resultsobtained are shown in figure 7.

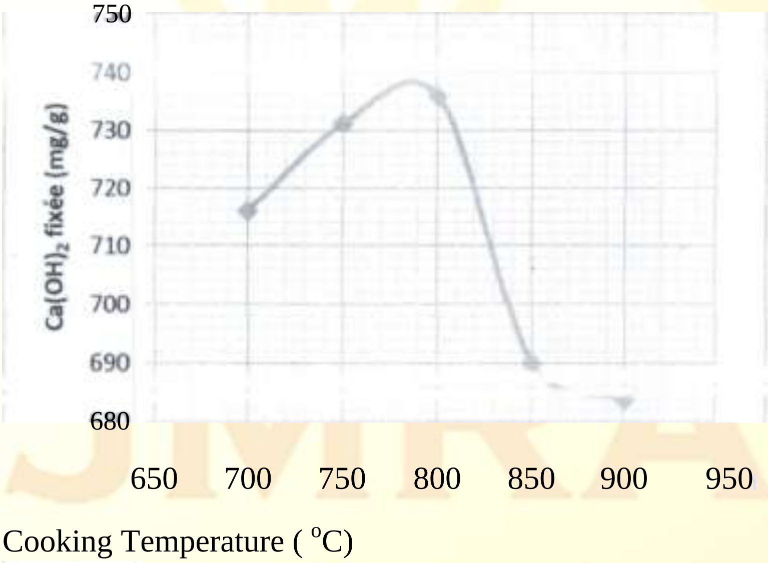


**Figure 7 • Influence of the firingtemperature on the pozzolanicity of the laterite**

Examination of Table 6 and of FIG. 7 revealsthat the fixation of lime by the bakedlateriteincreases, first, passes a maximum corresponding to 785 °C, and thendecreases.

For thispurpose, we have used the temperature of 785 ° C relating to 735 mg of fixed lime.

**4.1.3. influence of cooking time**

**Experimental**

Conditions :

- Cooking temperature: 785 oc ;

- Cooking time: 3, 4, 5, 6 and 7 hours ;
- Particle size: 80.78% passersthrough a 74 sieveobtained by grinding the laterite for 50 minutes reduced to a particle size of lessthan 2 mm.

The resultsobtained are shown in figure 8

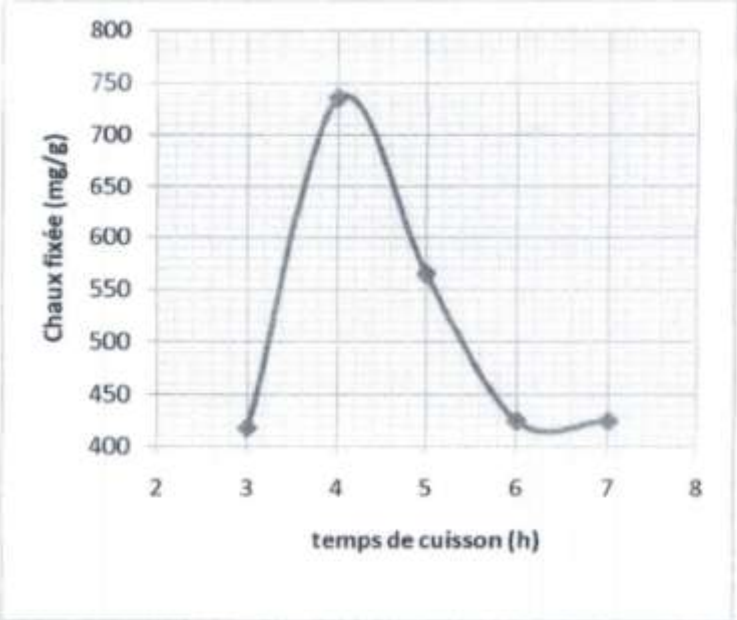


**Figure 8 • Influence of the cooking time on the pozzolanicity of the laterite**.

Examination of Figure 8 shows that the fixed lime increases, first, between 3 and 4 hours, goesthrough a maximum at 4 hours, and thendecreases.

Wethereforeretained the duration of 4 hourscorresponding to 739.9 mg of lime fixed per gram of pozzolan.

**4.1.4. Recapitulation**

Optimal recapitulations of the laterite of the Cities of the University of Lubumbashi into a pozzolanicmaterial are as follows:

- Fragmentation of the laterite must produce at least 80% of the passersthrough the 74 µm sieve ;
- The heattreatment of the lateriteshouldbecarried out at a temperature of 785 ° C for 4 hours.

Under these conditions, the productobtainedis capable of fixing 739.9 mg of lime per gram. .this value isgreaterthan the minimum required to qualifyanymaterial as pozzolan.

Wecanthereforesay, withoutambiguity, thatwe have obtained a pozzolan capable of beingused in the manufacture of pozzolaniccement.

### *4.2. FORMULATION OF POUZZOLANIC CEMENT*

***The pozzolanobtainedunder the above conditions was mixed with the clinker powder and gypsum in the proportions indicated in Table 4. The mixtures obtainedwerehomogenized in the ballmill. .the mortarsbased on the cementsobtained gave, in the compression tests, the breaking stresses, in MPa, as a function of the age of the specimens, the results of which are shown in figure 9.***

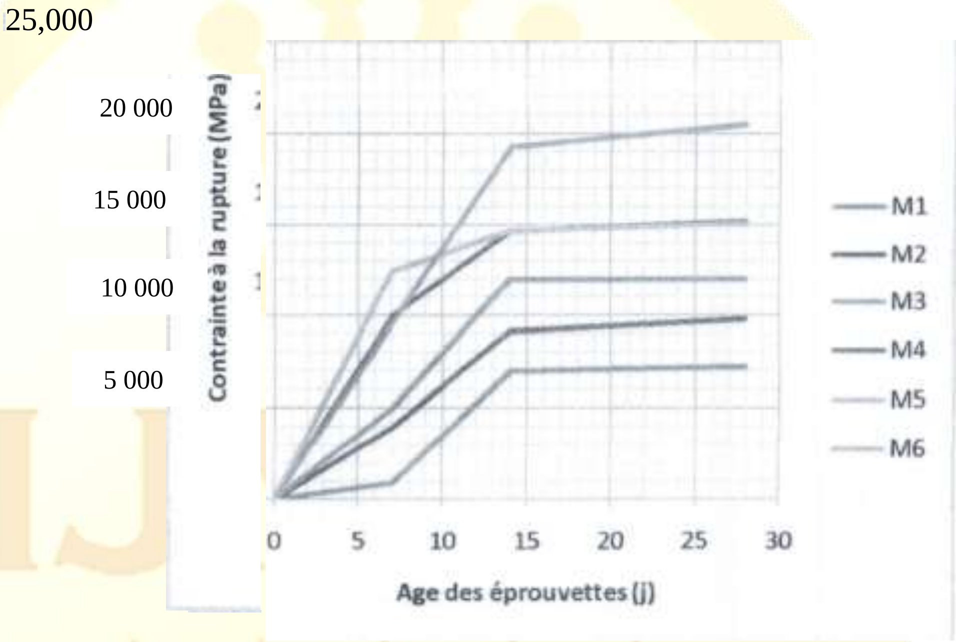


**Figure 9 : Stresses at break of specimens-age of specimens-cement composition**

***Examination of FIG. 9 shows that, whatever the mixture, the curvesincreaserapidly at first and thenstabilizeafter 14 days of age. .theirupwarddisplacement shows that the mortarbased on the M6 mixture has a bettermechanicalbehaviorthan all the othermortars. Nevertheless, mortarsbased on mixtures IV14 and M5 having a behaviorsimilar to thosebased on mixture M6 caughtour attention.***

*We have thusretainedthese mixtures whoselaterite content varies between and 04 a pal u Ulle tonne CIInKerwecanobtain 1.33 1.53 tonnes of pozzolaniccementagainst 1.05 tonnes of normal portland cement*

### *4.3. ACID AGGRESSION TESTS*

*The 28-day-old test pieces, shapedunder the same conditions as aboveweresoaked in water and in sulfuricacid solutions at and% .The mass lossescalculated for each mixture as a function of the immersion time are shown in Figures 10, 1 1 and 12.*

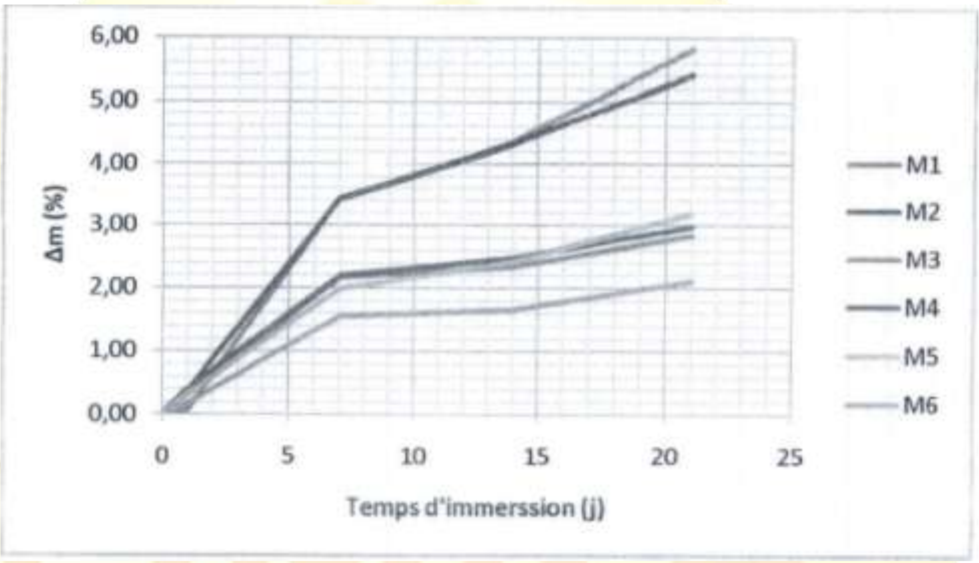


**figure 10 • Mass losses by immersion in water - residence time - cement composition**

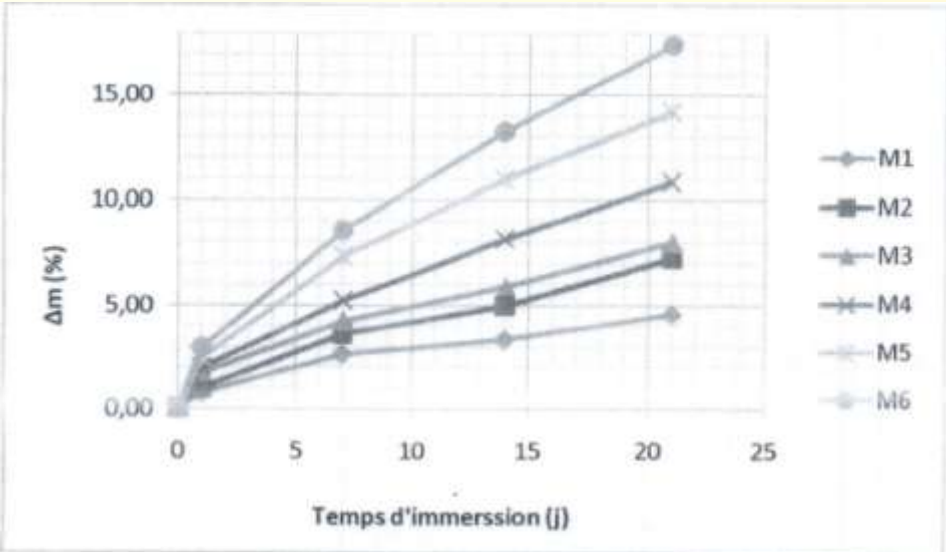


**Figure I I • Mass loss by immersion in 3% acid - residence time - composition of the cement.**

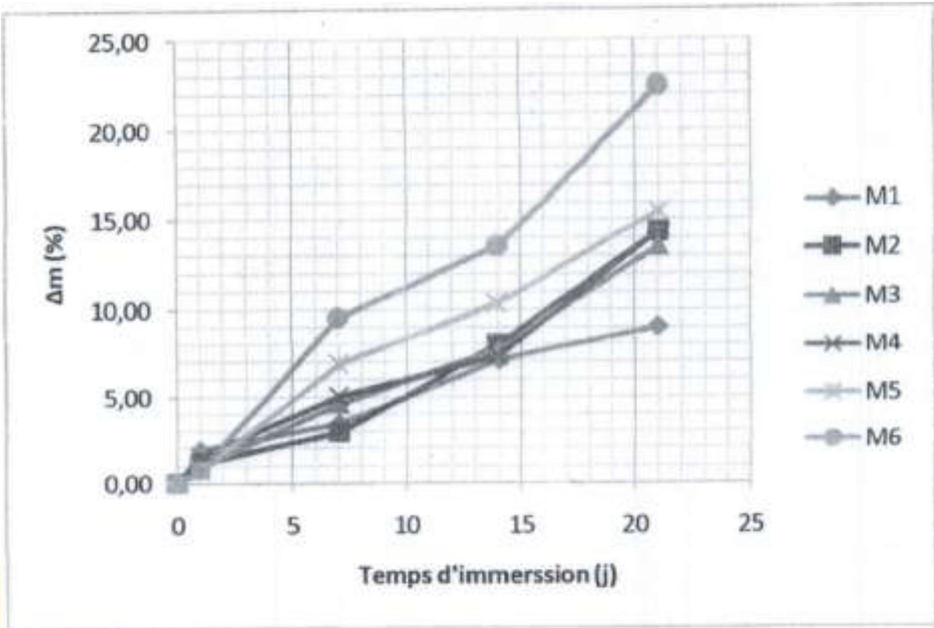


**Figure I I • Mass loss by immersion in 3% acid - residence time - composition of the cement.**

**Examination of FIGS. 10, II and 12 shows that, whatever the environment in which one findsoneself, the mass lossesincrease. These are important when the acid concentration increases. By immersion in water itis the mortarbased on M6 cementwhichresistsbetterthan the others. On the other hand, in an acidicenvironment, itis the mortarsbased on pozzolaniccementsthatresistbetter. Good results have been obtainedwithmortarsbased on M1 and M2 cements ,in order not to compromise the alreadyreducedmechanicalproperties, wepreferred to use M4 and MJ cements.**

## 5. CONCLUSION

In the light of the resultsobtainedwearrived at the following.It is possible to obtain a pozzolanfrom the laterite of the universitytowns of Lubumbashi by heattreatment capable of fixing 739.9 mg of lime per g of pozzolan. You have to heat the laterite at 785 ° C for 4 hours to getit. .thispozzolancanbesubstituted for the clinker in the proportions of 20 to 30% to have a pozzolaniccementwhose compressive strength of a standardizedmortarisapproximately **15.068 MPa**.

Have shownthat the mortarscorresponding to pozzolan proportions of 20 to 30% are stable in water as well as in weaklyacidic solutions (E 3 0/0) unlikemortarsbased on portland cementwhich are attacked by solutions acidseven at low concentrations.

The articles in citation adobe brick of keyword to the results of the materials in manufacture for the bricks of constructions of the houses, the roads and infrastructures of daily uses are the following the first article on the unbaked bricks of twoclays KALAVIONDO 35 Kgf / $cm^2$ and .38 Kgf / $cm^2$ , KALUBWE 52 Kgf / $cm^2$; the permeabilities are 3.54% for KALAVIONDO and 4.54% for KALUBWE.

The LTGS TOYOTA active masonry bricks used on the four Likasi sites, notwithstanding the descent on the ground, at the compaction load: 0.75 kN (or 10.61 Kgf / cm2); cooking time: 2.5 hours, compressive strength of about 200 Kgf / $cm^2$under the following conditions: fraction .of caustic soda in the raw mixture: 4%, cooking 150 ° C. DEA memory of a Co-author in continuation Use case (NaOH or KOH) 3%, LTGS "CROSS-LINING"; towardsactperformed in rhythmtowards a decreasenoticeablegreenhouseeffect in LTGS Bricks Less$T^o$C more than the first .made in prediction of the resultsafter training withtheseSupervisorsincluding the twoother Co-authors on USB and CONFERENCE SUR LES BRICQUES LTGS, the book 4th Ed. of 2015 Geopolymer: Chimistry and Applications and www.geopolymer.org by the Speaker Prof . .doc Joseph DAVIDOVITS in broadoutline the expectedresultsarround 10MPa - 15MPa experienceelsewhereopening the way to anotherthematictowards the GeopolymerCementbased on the alkali activation of Fly ash 'AAF' based on local materialspreliminarydraft insimilar course on the way to Thesisinitiated by Prof MUTAMBA MWEMA Edouard himselffromhispastgeneratingthisthird article in citation SlagBasedEnvironmentallyFriendlyGeopolymer…why not tobefore - projectPorfoliothesis AAFA Fly Ash-BasedGeopolymerConcrete UNIVERSITY OF AUSTRALIA PhD Studentsreceivedfrom Saint QUENTIN Headquarters GEOPOLYMERES ;USB supplytwoclayrawmaterials of $SiO_2$clayaround 50%, $Al_2O_3$ 25% and CaO 1.5% process at particle size around

38µm at 50 µm around**57MPa - 67MPa 60 ° C 'FLY ASH BASED WITH GP cement'**costproblemreagentapproach to see ALKALI ACTIVATED NATURAL POZZOLAN CONCRETE AS A NEW CONSTRUCTION MATERIAL ; www.groupemodulu.com the book Science and Materials Engineering William D.gallisster, Jr, modulo 2001 in our hands...wellknownCement GP betterthan Ciment PC to Handbook of chemical Engineering calculationpratice plants...citation **FASCICULE DE BREVET EUROPEEN EP 2 061 732 B1**:CIMENT GÉOPOLYMÉRIQUE À BASE DE CENDRES VOLANTES ET À GRANDE INNOCUITÉD'EMPLOI.

**BIBLIOGRAPHIC**

1.Technique de l'Ingénieur : Généralités Tome III, 4e ed. Tome VI, 1948.. ARRAMBIDE et DURIEZ : 'Nouveau traité de matériaux de construction,' 1e éd. Paris 1962.

2. RI. MELTZER: 'Cement lime, ceilings and walls,' annual book of ASTM standard 1979.

3. A. KOMAR. ' Matériaux et éléments de constructions' Ed. MIR. Moscou.

4. Pour la science édition française du Scientific. American numéro 20, 1979.

5. Centre technologique International de la pierre (ASBL, JOURNAL Belgique 1996.

6. ATHENA le savoir-faire Wallon no 126, 1997.

**7.Davidovits J,** Geopolymer : Chimistry and applications' 4thed. 2015.

8.**Video**training de Saint Quentin siege GEOPOLYMER/ FRANCE **Grand Maître Prof. Doc. Joseph DAVIDOVITS Coach (Icône planétaire de ce).**

9.**Bouterin C., Davidovits J.,** (2003). **Réticulation géopolymérique (LTGS**) et matériaux de construction. *Géopolymère*, **1**, 79-88.

10.aVidéo Conférence For Small environment of Small production'. **Bricks LTGS à VERONA 4th July2008 FORUM 1st International CERAMIC and BROTHERWOOD. NEWCOMER.**

**10b.FLY ASH BASED GEOPOLYMER CONCRETE CurtinUniversity of TechnologiePert Australiaporfolio**training de Saint Quentin siege GEOPOLYMER/ France.

11.**A. Bauer, G. Berger**, 1998, Kaolinite and smectite dissolution rate in high molar KOH solutions at 35 °C and 80 °C. AppliedGeochemistry, vol. 13, p. 905-916.

12. **American Society for TestingMaterials (ASTM), (**1979). Standard test methods for apparent porosity, water absorption, apparent specificgravity, and bulkdensity of burned refractory brick by boiling water.

13. **Institut des Géopolymères**. Articles sur les géopolymères (consulté le 10.01.2012) [en ligne]. Http : //www.geolypolymer.org/fr/ Article sur les géopolymère

14.**Xu H. and Van Deventer, J. S. J.,** (2000). The geopolymerisation of alumino-silicate minerals. *International Journal of MineralProcessing*, **59**, 247-266.

15. **Xu H. and Van Deventer, J. S. J.,** (2002). Microstructural characterization of geopolymers synthesizedfrom kaolinite/stilbite mixtures using XRD, MAS-NMR, SEM/ED.

16.**Caillère S., Henin S., Rautureau M.,** 1982. Minéralogie des argiles, II : classification et nomenclature. Masson, Paris, 1-189p.

17.**Cheng T. W. and Chiu J. P.,** (2003). Fire-resistantgéopolymèreproduced by granulated blast furnaceslag. *Minerals Engineering*, **16**, 205-210.

18. **Davidovits J.,** (2002). GeopolymerConference: 30 years of successes and failures in geopolymer applications. Market trends and potentialbreakthroughs. October 28-29, Melbourne(Australia),16p.

19.**Davidovits J.,** (1991). Geopolymers: Inorganicpolymeric new materials. *Journal of Thermal Analysis*, **37**, 1633-1656.