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Physico-Mechanical Characterization of Brick of (14x14x28 CM), and Formation of Brick Layer in the Community of Panda A Likasi

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Abstract: ***As the Democratic Republic of Congo is undergoing major changes, the need for construction and improvement of housing is crucial everywhere, both in the national territory and in the city of Likasi. In the municipality of Panda. For quality work and good resistance in the use of bricks commonly known as "safe", it is important to train manufacturing personnel so that these bricks meet the standards of globalization, for what not happened to elaborate theirs. This in the sense that we present in the lines that follow some physic - mechanical characteristics of the bricks compared to the middle of our research.***

Keywords: Physical and Mechanical Properties, Bricks, Training

1. Introduction

In the developing country as well as in the city of Likasi in general and in Panda commune in particular, the mechanization of brick making is still a problem for the majority of the population; because this mechanization requires very important means. To overcome this need, many people use manual molds to make bricks for the construction of their homes. Limited and reduced by the physical force exerted by man to compact the clay in the mold with a beat, compaction varies proportionally from person to person. As for cooking in the ovens, some use firewood, others fire, whose temperature is not kept constant.

This is not an obstacle to the evaluation and determination of the physic-mechanical characteristics of bricks, commonly known as "Tap - fort" when we know that they can meet or exceed the European or Belgian standards in the manufacture of bricks. Our reflection will focus on elements that will one day contribute to the development of a standard for the manufacture of these types of bricks. We start from the following fundamental question: • Is it important and necessary to train the brick makers on the brick making process in Panda Commune in Likasi City?

The provisional and anticipatory answer to this question would be on the one hand, the determination of the physic-mechanical properties of the "Tap-fort" bricks, and on the other hand the importance of the formation of the brick makers, especially during the period of manufacture, so that the different properties have determined allow one day to develop the standards specific to these bricks and respond to different aspects. To collect the data and verify our hypothesis raised by the question of our study; we used the experimental method supported by observation and maintenance techniques; our sample is composed of some brick makers from the municipality Panda. And the study extends over the period from the year 2015 to the year 2017 and is in the field of construction, especially in the municipality of Panda, but generally throughout the city of Likasi. It will interest not only the population of Panda commune, but also the entire population of the country.

2. Conceptual and Theoretical Aspects

1) Education

The complexity of society means that man needs education in order to adapt to it. For Mwenze wa Kyungu (2016, p112), "*education is a valuable instrument for changing the mentality of the individual, changing behavior and the transformation of their environments in order to improve their living conditions ...* " Many other authors have defined education according to their field of application:

For Radja Bin Saidi (2016), quoted by Mwenze wa Kyungu, education is "*a means, an instrument for understanding ignorance in the learner. It awakens latent knowledge in him by his abilities to change the environment in society".*

As for us, we will say that education is the apprenticeship of the profession for a specific purpose. That is, to train the man to meet the requirements of building standards in the manufacture of bricks.

2) Training

In this sense the formation of brick makers in the municipality Panda is understood as all the knowledge and know-how acquired in the field of manufacturing bricks "Tap-fort".

3) The brick

Standard EN.771-1 (2005, p3) defines brick as "*a masonry material made of clay or other clay material, with or without the addition of sand, fuel or other additives, raised to a temperature sufficiently raised to form a ceramic bond* ".

It is a terracotta material used as a building component for masonry, both for facing masonry and non-decorative masonry for interior walls (also called SB brick masonry).

The European standard (idem) makes a distinction between:

- Low density products (LD): bricks used for any use in protected masonry whose dry density is less than or equal to 1000 kg / m3.
- High density products (HD): bricks used for any use in unprotected masonry or bricks with a dry density greater than 1000 kg / m3

  This standard stipulates (ibid.) that "*it must be borne in mind that the standards mentioned above certainly specify criteria but do not impose any value on products. It is up to the designer himself to set figures that meet the criteria of the standard, such as weight and compressive strength, depending on the application he or she is considering.* " Thus, by determining the physic-mechanical properties of the "hard keys", even if they do not have the same values as those of already existing standards, we can also classify them according to their use in the Country and according to the different environments.

  The standards (NBN B 23-002 and B 23-003) classify bricks into three types:
- **The drawn brick** is made by means of a stretching machine. It is full or perforated. At least three of the six faces (one stringer and two ends) are made in such a way that they can remain visible (smooth, debarked, rough, sandblasted or not).
- **The brick made by hand** is obtained by introducing a quantity of clay paste previously sandblasted into a mold; this gives a typically ribbed appearance.
- **The pressed brick** is obtained by mechanically pressing the clay paste in the molds. A clean and angular brick of shape is obtained.

Of these three types of bricks, our work focuses on the second, which is that of hand-made bricks because, as we said in the introductory part more than 80% still use dobe bricks in our environment.

4) Physic-mechanical characteristics of bricks

They are determined by:

- The dimensional aspect of the bricks;
- The hygrometric properties where we determine the porosity that leads us to the absorption test, as well as other quantities such as: the specific heat of the brick, the equilibrium humidity, the thermal conductivity as well as the rate humidity;
- The stability of forms;
- Compressive strength;
- Reaction to fire;
- The frost resistance

a) Dimensional aspect

The Belgian Federation of Bricks (2005, p8) states that: "*The dimensions are always mentioned in the following order at the international level: Length x Width x Height (in mm)*". For this Federation, the individual dimensions of production can be determined according to (EN 772 - 16), the operation consists in measuring four times each dimension, from three external dimensions of the brick to the millimeter in order to have the average.

As part of our investigation, we propose to measure three times each dimension of these three dimensions of the brick that is to say the two extreme edges, then in the middle of the brick and this would give us reliable results on average.

The Federation designates by:

- Nominal size, the one used in the trade to designate a brick format.
- Dimension of manufacture, that which presents values slightly lower than those of the nominal dimension, that is to say those obtained by measurement.

b) Hygrometric properties

- The porosity of a material

  According to the Belgian Federation of Bricks (2005, p 13) it is the ratio between pore volume and total volume. The structure of the pores can take many forms: open or closed, accessible or not through canellas, etc. The pores of the bricks are generally interconnected.
- **Importance of porosity**

  Porosity has a decisive influence on certain properties of the brick: implementation, thermal insulation, frost resistance and aging, etc. Porosity is a complex notion that can not be reduced to a number. Easily applicable, methods of measuring water absorption are often used by the manufacturer to verify the regularity of production. According to Dr. E. Boehm-Courjault, EPFL-LMC, (2007, p. 33), "*the porosity of terracotta (TC) varies from a few percent to over 55%., The terracotta brick made of TC, 20 to 55% because of the spinning, not the big pores, but cracks.* "
- **The specific heat of the brick (J / kg.K)**

  Referring always to the Belgian federation, it is the amount of heat needed to increase the temperature of 1 kg of material by 1 Kelvin. Also called "specific heat". The specific heat c of the bricks is between 0.84 and 0.92 kJ / kg.K. As far as we are concerned, the masonry in brick is massive. We opt for the same values with regard to bricks commonly known as "type-fort"

- **Equilibrium humidity (vol%)**

This is the percentage of water maintained in equilibrium by the material under a given relative humidity. For this property, the problem does not arise so much for our research community because knowing that we have only two seasons. Bricks in most cases are still dry.

a) Stability of forms

The shape stability of a (construction) material is its ability to maintain its dimensions in a variable external environment.

b) Resistance to compression

According to the Belgian Federation of Bricks (2005, p. 17) the term "breaking strength" or "compressive strength" refers to the pressure required per square millimeter to break the material. This factor is measured on the real surface (gross) (= L x B) independently of the percentage of perforations and is expressed in Newton per square millimeter: N / mm2.

- **Individual compressive strength**

According to NBN B 24-201 (see above), the brick is subjected, after normalized mortar leveling, to a regularly increasing pressure between two plates until it breaks. In

(EN 772-1), a similar method is used on at least six bricks, the average compressive strength of which is then determined. For us, we took eight bricks to determine the average compressive strength given the size of the oven but also to try to analyze the cooking rate, and see if the whole temperature would be the same. Above and on both sides of the oven.

- **Average compressive strength** (NBN B 24-301 and NBN EN 771-1) According to the definition of (NBN B 24-301), this value is the arithmetic mean of the individual resistances measured in a sample of several bricks. In the European standard (EN 771-1), the determination of this value is less obvious. Additional criteria are imposed. Thus, no brick of the sample tested can have a compressive strength that is less than 80% of the average value. For bricks of category I (ie the bricks for which, to the internal control during the manufacturing process, is added a control by a third) the batch of bricks must reach this average value of the compressive strength with 95% certainty. The calculation is done using statistical methods, usually based on a normal Gaussian distribution.

a) The reaction to fire

The reaction to fire of a building material is the set of properties relating to its influence on the birth and development of a fire. This property should not be confused with the fire resistance of brick masonry. The brick being of category (AI), this property is the same for our study, because the brick is never conducting fire.

b) Frost resistance

Frost resistance is the degree of resistance of a material to withstand a succession of freeze-thaw cycles. It is generally accepted that gelatin is due to the expansion of water in the pores in case of frost. If the pores are completely filled with water and the latter can not be removed in time during freezing, the ice exerts internal pressure on the brick and burst it. The frost resistance is determined on the basis of standardized tests. Not knowing a freezing problem in our city, this property has no influence on our bricks.

3. Methodological Aspects

1) Population

Ibrahim Lo. (2013, p. 24) defines the population as *"the totality of the elements or the constituent units of a set. This term may as well designate a set of people, organizations or objects of any nature whatsoever*". For us, the population refers to all individuals or groups of individuals subject to scientific investigation. As part of our investigation, the population is made up of all manufacturers of bricks (brick makers), the town Panda in the city of Likasi.

2) Sample

J-L, Loubet Del bayle, (2000, p25) defines the sample as a *"set of subjects, elements or individuals drawn from the population; the elements from which information has been collected in terms of qualitative or quantitative data* ". Our field of investigation being the commune of Panda, we took the sample, of 33 brick lighters distributed in team of 5 and 4, in order to see their method of manufacture and to estimate the number of blow that they exert to compact the brick in the mold that will allow us to better propose and adapt their education in the field. Indeed, we took eight pieces (8 pieces) baked bricks 6m long, 5m wide and 3.8m high. The choice was made in the following way: two at the hole, two in the middle of the oven, two above the oven and the last two taken on both sides of the oven.

Table 1: Presentation of the sample according to the subjects on the basis of the few targeted brick makers

		Number Group	Membership	Location	Number of shots / Brick
N°	DESIGNATION				
1	Brick layer	5	private	C/Panda, Q/ Kavytcha	Variable3, 4,…
2	brick layer	5	private	C/Panda, Q/ Kavytcha	Variable3, 4,…
3	brick layer	5	private	C/Panda, Q/ Saint François	Variable3, 4,…
4	brick layer	5	private	C/Panda, Q/ Saint François	Variable3, 4,…
5	brick layer	4	private	C/Panda, Q/ Saint François	Variable3, 4,…
6	brick layer	4	private	C/Panda, Q/ Zigné	Variable3, 4,…
7	brick layer	5	private	C/Panda, Q/ Zigné	Variable3, 4,…

Source: Data collected in the commune Panda city of Likasi

Comment: The data in this table show that out of the seven teams taken as samples, there are two from the Kavytcha district, two from the Zigné district and the third from the Saint François school side.

4. Method and Techniques

As part of our study, we used the experimental method and it allowed us to determine the manufacturing dimensions of bricks, their absorption rates, compressive strength and dispersion.

- **Observation** allowed us to study and monitor carefully the different behaviors during the different tests that were submitted to them.
- **The maintenance**: this technique allowed us to come into contact with the brick makers, to discuss and have knowledge about their method of manufacture, the size of the bricks, and their drying period.

Search Results

1) Control of the dimensions

By dimension control, we determined the dispersion and tolerance of the brick.

Operating mode

- Take a sample of the bricks
- Determine each dimension by taking three millimeter measurements on the sample taken. These measurements are made on the one hand, on one side of the brick

between edges and on the other hand, in the middle of the brick.
- The average of the measurements being the corresponding dimension.

Table 2: Presentation and analysis of results according to the manufacturing dimension test

Bricks	Length (mm)	Thickness (mm)	Height **(mm)**	Bricks	Length (mm)	Thickness (mm)	Height **(mm)**
1	270	140	145	**5**	265	130	130
	270	140	140		260	130	130
	270	142	142		265	130	130
2	270	140	130	**6**	270	135	130
	270	140	130		270	135	130
	270	140	130		270	135	130
3	265	140	135	**7**	265	135	135
	270	140	135		270	140	135
	270	135	130		270	140	140
4	270	140	130	**8**	265	135	130
	270	140	130		265	135	130
	270	135	130		265	130	130

Source: Data collected in the commune Panda / city of Likasi
Comment: The data in this table show that of the eight bricks in our sample, we have as average dimensions:
Average length = 268.12 mm ≈ 268 mm
Average thickness = 136.75 mm ≈ 138 mm
Average height = 132.79 mm ≈ 133 mm

a. **RI dispersion calculation of bricks**
- Length = = 9.8 mm ≈ 10 mm
- Width = = 7 mm
- On the height = 1mm

b**. Tolerance on the dimensions of the bricks**
- of manufacture or 3 mm for the length
= 6.4 mm ≈ 6 mm
- of manufacture or 3m for the width
= 4.6 mm ≈ 5 mm
- of manufacture or 1mm for the height
= 0.57 mm ≈ 1 mm

2) Density
According to N.B.N B 24.206: testing of masonry materials, the apparent density of materials is the ratio of the mass of the material to the dry state and its apparent volume.

$$\gamma = \frac{G_s}{V}\left(Kg/m^3\right) \text{Ou } \left(g/m^3\right)$$

Or Here are the results of the test

Table 3: Presentation and analysis of the results according to the determination of the density

bricks	Gs(kg)	v (m3)	ϒ (kg/m3)	bricks	Gs(kg)	v (m3)	ϒ (kg/m3)
1	8,5	0,0055	1545,45	**5**	7,935	0,0045	1763,33
2	7,85	0,0053	1481,13	**6**	7,87	0,0047	1656,86
3	7,9	0,0049	1612,24	**7**	8,45	0,0051	1656,86
4	7,57	0,0049	1544,89	8	7,78	0,0048	1620,83

Source: Data collected in the commune Panda / city of Likasi
Comment: The data in this table show that of the eight bricks in our sample, we have the following average density: 1610, 20Kg / m3

3) Test of the compressive strength
According to NBN B24.201, Test of masonry-compression materials, the brick is, after leveling with a standardized mortar, subjected to a regularly increasing pressure between two plates until it breaks.

a) Materials used
We used:
- A PERRIER press, type I 75, N ° 23016
- A machete

b) Operating procedure
- Measure the gross area (Lxb) of the half brick
- Place the two halves leveled brick with standardized mortar between two plates
- Applied pressure by means of a lever until breaking
- Read the pressure gauge on the pressure gauge

We will have fm or Rm = P / S in (N / mm2) where

Note: Since the compression and salt absorption tests were to be done on the same day, from which we divided our brick sample in half so that a part would allow us to test for compressive strength and the other for absorption.

Table 4: Presentation and analysis of the results according to the determination of compressive strength

	bricks N° 3	bricks N° 4	bricks N° 6	bricks N° 7	Average
Résistance à la compression	2,23	2,15	4,83	1,35	2,64
f_m (N/mm^2)					

Source: Data collected in Panda Commune / Likasi City

Comment: The data in this table show that on the four bricks of our sample, we have as average resistance: 2,64N / mm2

* **Calculation of the average standardized resistance:**
fb = Rm · δ · χ
or δ = 1.3 approximate value of the brick of 14x14x28
χ = 1 air-dried brick
fb = Rm · δ · χ = 2.64 x 1.23 x 1 = 3.25 N / mm 2
With:
- δ: form factor of the sample tested (according to NF EN 772-1)
- χ: coefficient dependent on the conditioning of the elements
- Rmc: declared average resistance of the elements

4. **Water absorption test**
The Belgian standards give various methods of testing relating to the absorption of water, which each give some information on the porosity:

Water absorption after 48 hours of immersion (NBN B 24-203)
The brick is also immersed in water, but it is totally submerged as soon as its upper face becomes visibly wet. The increase in weight is measured after 48 hours of immersion. As far as we are concerned, it is also the method that we applied for our sample in order to be able to determine the percentage of absorption of our bricks.

Operating mode

- Weigh the dry brick to have the dry mass Gs
- Immerse the brick in the water, then re-weigh to have the absorbing mass Gab
- Calculate the Hp absorption by weight

$Hp = \frac{Gab - Gs}{Gs} x100$ en %

Table 5: Presentation and analysis of the results according to the determination of the water absorption

brick	Gs (g)	Gab (g)	Hp (%)
1	8500	8985	5,71
2	7850	9870	25,73
5	7935	9060	14,17
8	7780	9880	26,99
Average			18,15

Source: Data collected in Panda Commune / Likasi City
Comment: The data in this table show that of the four bricks in our sample, we have the average absorption: 18.15N / mm2

Table 6: Comparison of the results

Dimension	Dispersion Maximum	Differences of Smaller and Larger
Length	10 mm	10mm
Larger	7 mm	10 mm
Height	1 mm	10 mm

Source: Data collected in the commune Panda city of Likasi

Comment: The data in this table show that the dispersal condition is not respected because the differences of smaller and larger values should be smaller than those of maximum dispersion.

Discussion of the Results

The results presented after the descent on the ground show that it really takes an education of brick makers. Although some physic - mechanical properties are nearby and meet European and Belgian standards, several efforts are still needed to standardize these bricks.

1) Dimensional aspect

Considering the dispersion, the European standard, limits according to EN 771-1, (op.cit., 2005, p10) the maximum dispersion of the measurements, affirming that: "*that is to say the difference between the largest and the the smallest measured value of bricks taken individually, must belong to one of the categories, previously defined* "

This explains the irregularity in the joint. At the same type of masonry, you will find that there are joints of 3 cm, 4 cm, ... Or in construction the joint must be the smallest possible to resist well because it is the weakest place of masonry.

The fact of not having the same number of blows, creates a very large dispersion in the bricks. Hence a large difference in the dimensions, (thickness and height).

2) Resistance to compression

In terms of compressive strength, eco - construction says: "The theoretical Compressive Strength has to vary from 10 MPa to 40 MPa".

The main weakness of clay brick is its low tensile and shear strength. Technical elements such as chaining, shores and wall heads must be particularly studied. In practical terms, the compressive strength is as follows:

- Old solid brick: 5 to 40 MPa
- Solid or perforated brick: 8 to 40 MPa
- Honeycombed brick: 2 to 5 MPa
- Honeycomb porous micro-brick: 8 to 10 MPa

In the first case, which is that of the old brick, the compressive strength is 5 to 40 MP. For our values found, the average being **3.25 MP.**

Indeed, we realize that the value is very small. This testifies the non-compliance, by the brick makers, the compaction of bricks. This is the importance and the need of training in the matter to manufacturing personnel.

In the European standard EN 771-1, (op cit cit 2005, p17), no brick of the tested sample can have a compressive strength lower than 80% of the average value. But on our bricks tested, this condition is not only, not respected, but also one of the sample brick is more than double the average. This translates a great dispersion, and the inhomogeneity of the masonry.

For a good resistance of the house, for example, there must be homogeneity in the masonry. But with our bricks, it happens that in the construction all the bricks are not homogeneous, that is to say there is a very large gap in the compressive strength. It is among the causes of passive cracks in houses built with the type of strong, apart from the collapse of the ground due to the load imposed on it.

This leads us to affirm that there is the irregularity of production in the "tap-fort" and is explained by the fact that the manufacture is manual and is done in a disorderly way. In fact, to shape the shard, compaction is done manually using a beating.

As such it is obvious that the energy deployed by brick makers to compact the earth mass in the mold can not remain constant throughout the production. The energy deployed by a brick makers decreases as the production progresses. And this energy is influenced by several factors, including fatigue, health status, the atmosphere of the day, age, etc.

The number of strokes in the manufacturing process is not uniform. The brick makers attack it in a disorderly way. As a result, the resistance of the bricks is variable thus creating a large dispersion. Add-on, in addition that the duration in the manufacture is a very important factor in order to keep constant the force of manufacture.

Since in the brick makers head the quality does not matter to them, because he runs behind the time, he tries to maximize the number of bricks they have set to achieve per day, if at the beginning they used five costs for a brick, they reduce the amount of clay in the mold and reduce the number of shots as they progress.

This affects the other properties of the brick such as water absorption, density, shape appearance, With regard to the water absorption; our samples exceed the limit which is 15% in the general case.

3) Baking bricks

According to eco-construction: "clay bricks are compressed and then fired at a temperature between 700 and 1000 ° C".
The manufacture of the baked bricks can only be done in specific ovens. It is a material of excellence for the construction as well for the monuments (Wall of China) as for simple dwellings.

Contrary to what eco - construction has announced, Alain GYRE, in his article inspired by the explanations of Jean - Pierre Test at shows that: "*These ovens are made of the same raw bricks for cooking. The base of the pyramid has a number of outbreaks. These fireplaces are filled with wood, then the brick makers continue the construction with the raw bricks previously dried in the sun. The bricks are arranged so that the flame is divided and distributed as much as possible in the body of the pyramid. The upper part is covered with earth and the walls are covered with earth*".

This is the same technique used in the municipality of Panda for cooking bricks. But the cooking temperature is not respected at these kinds of ovens since the furnace body consists of the bricks themselves. As the heat rises through the openings left to reach the summit, there is always escape of this heat. Due to the quantity of wood and embers used, cooking is not uniform. Many of the top bricks do not get enough heat for perfect cooking.

CONCLUSION

The standardization of number of hits in the manufacture of bricks called "type-fort" being imperative for the standardization of the latter; a formation of brick makers proves necessary. Man needs to develop his habitat and his vital place. Being limited by means, putting at his disposal the methods and techniques in the manufacture of bricks, he will participate in the social development of his country.

This is the case of brick makers in the municipality of Panda in particular and the city of Likasi in general. The tests on the bricks prove that, in terms of density, they are classified in class (HD).

Not only are their walls not very smooth, these bricks hardly respect the aesthetic aspect. In most cases we use the plaster.

To overcome this, brick makers must know how to compact the brick because when it undergoes a good compaction, the faces become smooth. So the standard will be respected. Note that the master piece in the standardization of the brick, is the brick makers. To do this, it is necessary to organize, in the form of seminars, training to adapt manufacturing to international standards.

To make these bricks very effective in construction, we propose to design and make mechanical beating in order to produce homogeneous "tap-fort" and to get to work steadily.

References

[1] Alain GYRE, two techniques for cooking brick, article online dark circles.org/IMAGES/2007/the%20brick. p.df
[2] E. Boehm - Courjault, Terracotta and Masonry, Online, WW. Country of Belgian Brick Federation, Manuel Masonry Terracotta, Brussels, 2005
[3] Ibrahim Lo, Social Science Research Methodology, PUF, Paris, 2013 UNILI, 2017
[4] J-L, Loubet Del bayle, Introduction to methods of social sciences, LEPT, Paris, 2000, p25
[5] MWENZE WA KYUNGU, E.J., Philosophy of Education, LUBUMBASHI, 2016, p112
[6] RADJAN BIN SAIDI, Ancient Africa: Cradle of Modern Civilizations, PUL, Lubumbashi, 2016.

ANNEX

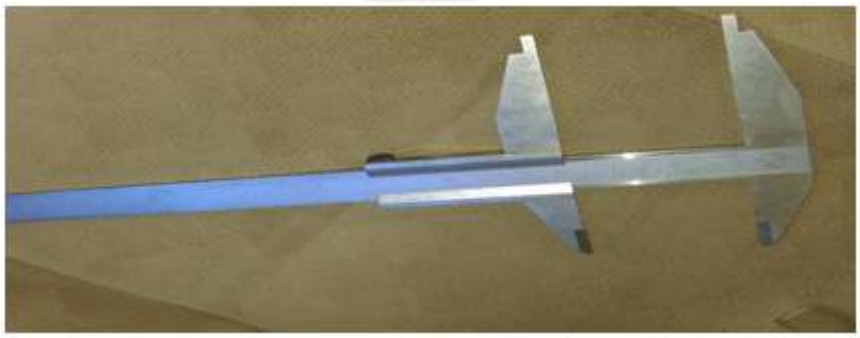
Materials and Materials Used

Brick tap-strong 14x14

Automatic switch August Santer GMbH D-7470

LUCTOR Van Breestraat 14

Press Perrier I 76 No. 23016



Calipe