

PHYSICOCHEMICAL CHARACTERIZATION OF RAW MATERIALS FOR THE MANUFACTURING OF BRICK

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Abstract:-

Brick manufacturing is a traditional activity carried out by the practical knowledge transmitted person to person, why there is no documentation on the raw material and manufacturing process control. The objective of this study was to determine the physicochemical characteristics of the raw material used in the fabrication of the Bricks, as a first instance to be able to make future changes for the quality assurance of the process that allow increasing the resistance to compression of the bricks. A mechanical test about the compressive strength of bricks before and after heat treatment was made. In the analysis of elemental composition, the presence of the following elements was found: C, O, Na, Mg, Al, Si, K, Ca, Ti, Fe. These elements allowed to obtain a compressive strength of the bricks of 10 to 13kg/cm² without heat treatment and 20 to 40 kg/cm² with heat treatment. Morphologically particles of 5 to 300 micrometres were observed in the raw material, and in the Bricks of 15 to 250 micrometres. It is concluded that the great variation of particle size of the raw material leads to a low compressive strength. Other studies with more control in the homogenization of particle size are suggested to obtain greater compression strength. Besides the temperature control in the kiln used to heat treatment is needed. The International Standard ITINTEC 331,017, and the Standard NMX-C-404-1997, establishes 60N / cm² and 24kg / cm² as minimum respectively. This study serves as a basis for further studies to help control and ensure the quality of the bricks.

Keywords: - Brick, Morphology, chemical composition, Compression resistance

INTRODUCTION

A brick is a ceramic piece, generally orthopedic, obtained by molding, drying and cooking at high temperatures of a clay paste, whose dimensions are usually 24 x 11.5 x 6 cm. It is used in masonry, for the construction of walls, houses, industries, etc. It is estimated that the first bricks were created around 6,000 BC. (Tell Mureybet and Ali Kosh (Archaeological sites)).

The brick is unalterable to moisture and has as a cooked material, a very useful network of capillary ducts. Its capacity to retain moisture and its thermal inertia are large¹. One of its characteristics is to absorb the humidity of the environment with more water vapor pressure, transfer it through its capillary network and dissipate it in the environment with less pressure. The brick wall "breathes" until it is dry. For this reason, it is suitable for constructions destined for humid processes, as long as the breathing of the brick is not impeded. The thermal conductivity of brick κ is moderate². It is important that the conductivity is proportional to the conductivity of the water vapor. This means that in each section of a brick wall, when the temperature drops, the water vapor pressure decreases, therefore no condensation water is produced. If a wall is not prevented from "breathing" its cold side remains dry.

The Olmecs (1200 BC), for the building of La Venta (Villahermosa, Tabasco) used clay red and yellow clay.

The Mayans made large and impressive constructions from the Middle Preclassic period and large cities. The most notable monuments are the pyramids that they built in their religious centres, next to the palaces of their rulers. All the stone for the Mayans structures seems to have been taken from local quarries; it was often limestone which, recently extracted, remained sufficiently soft to be worked with stone tools, and only hardened after a while, losing its natural moisture. In addition to the structural use of limestone, they used crushed, burned and beaten limestone that possessed properties similar to cement and was widely used both for wall finishing and for joining stones; In the Valley of Mexico (in the preclassic period, 700 BC) masonry was already used for various purposes^{3, 10}. The present study aimed to characterize the soil used in the fabrication of the brick, since it is an important aspect on which the resistance of the same will depend.

Experimental details

The experimental work was made as follows:

1. Tepetate, clay and land of the place (soil) samples were collected in the process.
2. The raw material was mixed in the following proportions:
 - 2.1 Sandy Tepetate (25%)
 - 2.2 Taffy Tepetate (25%)
 - 2.3 Clay (Red clay) 25%
 - 2.4 Land of the place 25%
3. All Materials were sieved with a mason's coat.
4. Materials are kneaded with approximately 20% water
5. The mixture was beat until a suitable consistency to be placed in mold
6. The mold was sprayed with sand
7. The mold was filled with the dough.
8. The material protruding from the mold is cut with a trimmer
9. Remove the partition from the mold and place it face up in rows on the floor.
10. Allow to dry on the floor for 4 days
11. The brick is dried in the sun for one month in the rainy season. In other season during 15 days
12. Put the bricks in the oven for cooking for 30 hours.
13. The bricks were characterized (Figures 10, 11, 12).
14. The chemical composition as well as the morphology were characterized with a scanning electron microscope JEOL JSM-5900LV. (Table 1 and Figures 1, 2, 3, 4, 5, 6, 7, 8, 9).
15. The compressive strength of the Bricks was measured with an universal machine for tension and compression test (Table 2)

Discussion

1. As can be seen in Table 1, the three types of earth used for the mixture of the raw material to be used in the manufacture of the bricks present the same chemical elements: C, O, Na, Mg, Al, Si, K, Ca, Ti, Fe, only the one with the highest content of all of them is the clay.
2. The tepetate of San Lorenzo Cuauhtenco origin had a particle size of 50-300 μm , a very variable size due to the agglomeration of particles, which form clusters (Fig 1).
3. The clay of San Lorenzo Cuauhtenco had a particle size of 75 to 150 μm . As in the previous case, it presents conglomerates, due to a heterogeneous mixing operation (Fig 4).
4. As for the soil of San Bartolomé Tlaltelulco, particles between 5 and 90 μm were found (Fig 7).
5. The finished product (brick) had a particle size of 15 to 250 μm , which gives it different porosities throughout the brick, which can be the cause of the reduction of the compressive strength of the bricks (Figs 10).
6. As can be observed in the three types of soil, different particle morphologies, typical ovoid characteristics of the clays, partially folded edges characteristic of the potassium feldspar, as well as spherical forms were found.
7. The chemical element silicon denotes the presence of quartz.
8. In table 2 it is observed that the compressive strength of the Bricks increases twice after the heat treatment.

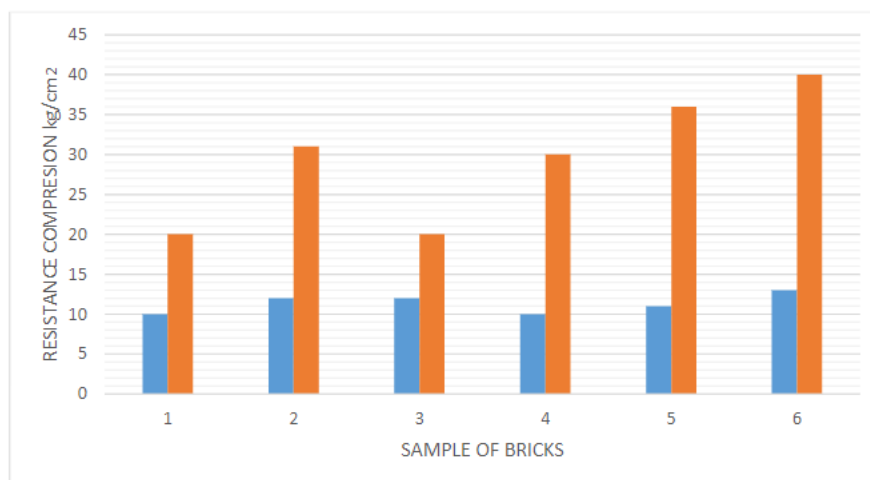
9. In table 1 and graphic 1, you can see, that only one brick presented 40 kg/cm² of resistance. The other bricks tended to the specified minimum value. Is necessary to do more test reviewing and controlling the process to obtain greater resistance of compression.

Table 1. Chemical composition of the raw material used to make the brick

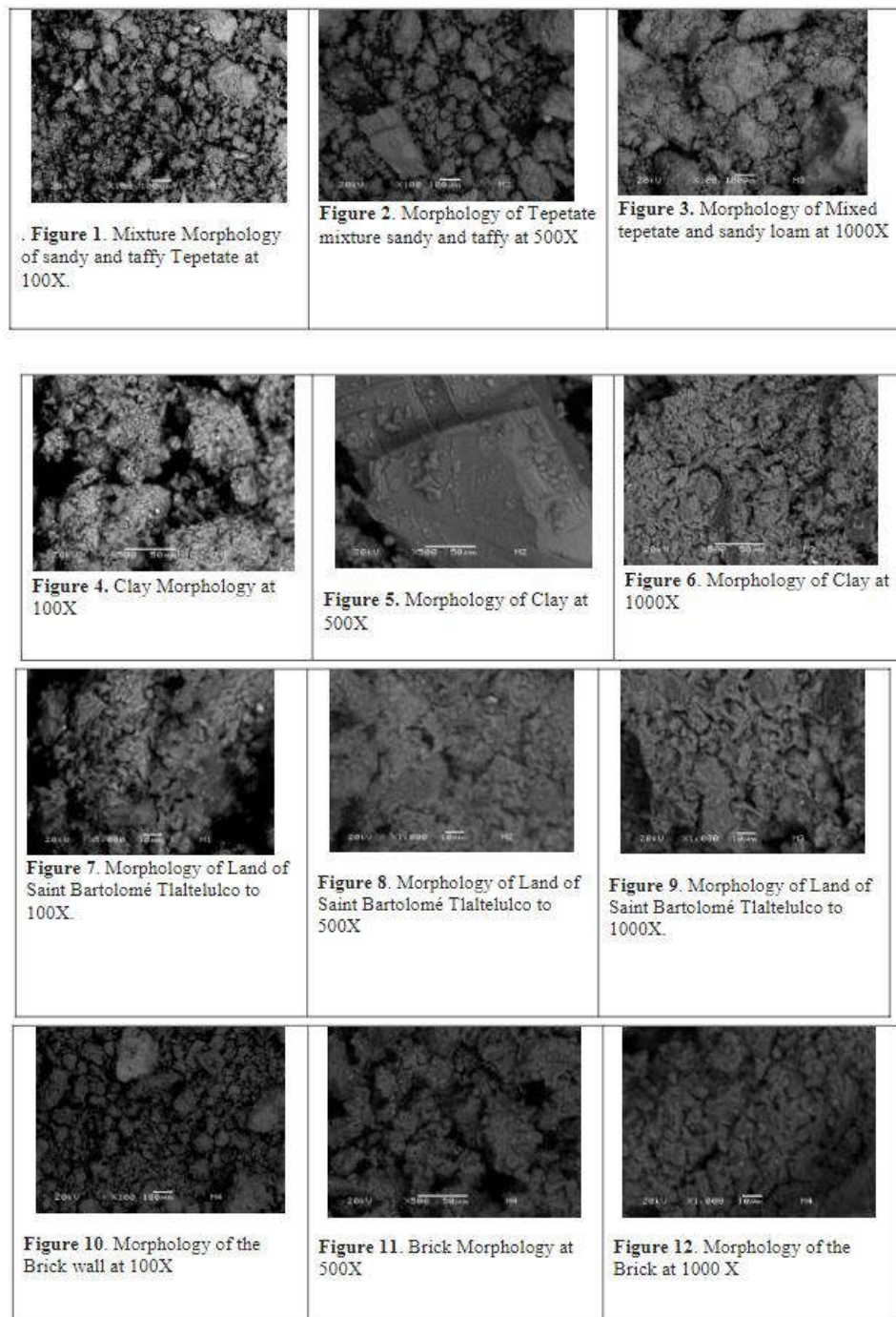
Chemical Element	Mixture of Tepetate taffy and sandy (% in weight)	Clay (% in weight)	Land of the place (% in weight)	Brick (% in weight)
C	19.5335	28.60929	24.35256	21.42389
O	39.94749	38.20288	40.03435	40.68084
Na	1.145633	1.089505	0.94752	0.958502
Mg	0.238112	0.205132	0.150851	0.312102
Al	9.985983	7.591485	8.232642	8.644496
Si	21.60917	17.48403	19.35269	19.97081
K	0.793324	0.78684	0.826279	0.881178
Ca	2.051583	1.442272	1.214419	1.346965
Ti	0.476083	0.37541	0.393837	0.461273
Fe	4.21912	4.213162	4.494851	5.319934

Table 2. Resistance to Compression of bricks manufactured in traditional oven of Saint Bartolomé Tlaltelulco

Brick	Resistance of Compression in Bricks without Heat Treatment (Sun dried)	Resistance of Compression in Bricks with Heat Treatment
1	10 kg/cm ²	20 kg/cm ²
2	12 kg/cm ²	31 kg/cm ²
3	12 kg/cm ²	20 kg/cm ²
4	10 kg/cm ²	30 kg/cm ²
5	11 kg/cm ²	36 kg/cm ²
6	13 kg/cm ²	40 kg/cm ²



Graphic 1. Compression Resistance of Bricks with and without Heat Treatment



Conclusions

The results obtained allowed to present a series of morphological characteristics of the raw material used in the manufacture of the San Bartolomé Tlaltelulco brick, as well as to determine the presence of chemical elements characteristic of quartz, feldspar and clays. The microscopically observed particle size allows to conclude that there is a lot of variation, which contributes to the compressive strength of the bricks, which tends to the minimum value established by the applicable Normativity. It is suggested to do more tests on the control of the size of the raw material, as well as the heat treatment, to increase the resistance to compression of the brick.

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References

- [1].Fernando, Bárbara Z., Construction Materials and Procedures, Mexico 1955.

- [2].Plazola, Cisneros Alfredo, Norms and Costs of Construction, editorial
- [3].Juárez, Badillo, Soil mechanics Editorial Limusa, Mexico, 1980, Volume 1.
- [4].ITINTEC 331.017 Technical Standard Peruvian 1976.
- [5].NMX-C-038-ONCCE-2004 Determination of the dimensions of bricks, partitions, blocks and walls for the Construction.
- [6].NMX-C-404-ONNCCE-1997 Specifications and test methods
- [7].NMX-C-036-ONNCCE- 2004 Resistance to compression-method test.
- [8].Silva Acevedo, G.; Deleon Argüello, J.A. (2009), "Determination of design parameters to compression clay masonry red annealed with mortar cement-lime-sand 1: 2: 10 ", Thesis of Degree, Faculty of Engineering, Autonomous University of Chiapas.
- [9].Official Gazette of the Federal District (2004), "Technical Norms Complementary for Design and Construction of Structures Masonry ", District Government Faith.
- [10]. Serrano G. (1997), "Manual de Prácticas de Laboratorio de Resistencia de Materiales", Facultad de Ingeniería, UAQ.
- [11]. Tena, A. (1997), "Materiales y elementos constituyentes de las mamposterías", Diplomado en análisis y diseño de estructuras, Centro de Educación Continua, Facultad de Ingeniería UAQ.
- [12]. Cabrera, O. y Muñoz, M. (2002), "Estudio de las propiedades físicas y mecánicas del tabique rojo recocido, utilizado en la construcción en el Mpo. de Querétaro", Tesis de Licenciatura de Ingeniero Civil, FI-UAQ, Querétaro.