Contribution To Study Of The Influence Of Lime Addition On The Thermo-Mechanical Properties Of Hajira Clay-Based Adobe.

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Abstract –This research topic consists of using local materials to build a construction low consumption. The aim of this project is to evaluate the behavior of the El hadjira clay-based Adobe by adding lime in different percentages. This technical study is based on the application of tests for the mechanical and thermal characterization of the latter. We made some samples of the tested Adobe, which gave good thermal and mechanical properties, in order to try to use them in the construction field. We set the percentage of gravel and clay, and that of the addition of stabilizer (lime) to 1% up to 5% by mass.
The results of these tests have shown that the percentage increase of lime is useful to improve the mechanical behavior. Compressive strength increases up to 43% compared to the reference sample. The results also show that the thermal properties remain very good which ensures a construction low consumption.

Keywords: Adobe, construction, lime, mechanical characteristic, thermal characteristic

I. Introduction

The most well-known and most often cited definition is that of F. Cointeraux in "Ecole d'architecture rurale et'économique, Paris 1790"[5] : "Adobe is a process according to which houses are built with earth, without being supported by any piece of wood, and without mixing it neither straw nor stuffing. It consists in beating, bed by bed, between boards, to the ordinary thickness of the rubble walls, the earth prepared for this purpose. Thus beaten it binds, takes on consistency, and forms a homogeneous mass that can be "raised to the heights necessary for a dwelling."
Adobe is, therefore, a monolithic clay wall masonry technique, composed of superposed layers of compacted earth. The resulting wall is a load-bearing wall. It is 50 cm thick on average, sometimes more. The density of traditional adobe is about 1.7 to 1.9 rpm[17]. Adobe buildings commonly have two levels. Some, particularly in urban areas, may have three or even four levels.
Our research work consists in valorizing the clay and sand of the dunes of the Ouargla region by incorporating it and using it to make a Adobe. In our work we have chosen gravel to make a adobe based on these materials. The south of Algeria is an example of the hot and dry regions of our country, is also an example of a region where the past has been built of earth and local stones (Ksores); but unfortunately in recent times concrete has been built, a material not adapted to climatic conditions
To this end, this study has been launched. From a global point of view, the aim of our research is to make a Adobe based on local materials. Then proceed to its thermal and mechanical characterizations.

II. Materials and methods

In this section, we study the characteristics of the different materials used in the manufacture of Adobe.

II.1. El-Hadjira clay

Raw clay generally contains elementary particles whose grain diameter is less than 2 micrometers (<2μm) which represent the crystalline individuals (pure mineral phase) called clay minerals responsible for its properties such as swelling, plasticity and adsorption properties.

For our study we used El Hadjira clay.

Figure 1. clay of El Hadjira.

We performed the following tests on clay:
- Granulometric sedimentation analysis;
- Chemical analysis;
- X-ray diffraction;
- Atterberg limit;
- Dry density;
- Methylene blue.

The results of sieve size analysis (the NF P 94-056 standard) and sedimentation sieve size analysis (the NF P 94-057 standard) are represented on the following curve:

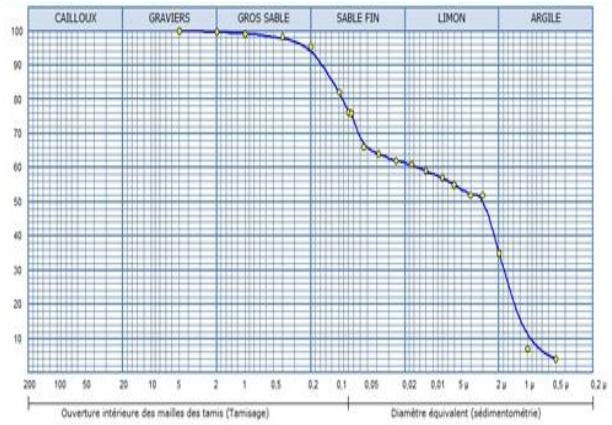

Figure 2. Particle size curve of clay of El Hadjira.

The results of the granulometric analysis by sedimentation show that our soil consists of approximately: 05% coarse sand, 33% fine sand, 27% silt and 35% clay.The results obtained are as follows:

Table 1. physical characteristics of clay

Characteristics	**Résultat**
The dry density (NF P 94/064)	P =2.06 g/cm^3
Methylene Blue (NF EN 933-9)	VBS = 4.8
Atterberg Limit (NF P 94-051)	WL= 46.50 % WP = 21.21 % IP = 25.29 %

According to Atterberg and Burmister, and by its plasticity index (IP = 25.29) our clay has a high plasticity.The main results of the chemical analysis are presented in the following table:

Table 2. Chemical analysis of clay

	Composants	Percentages(%)
Insolubles NF P 15–461	Insolubles	84
Sulfates BS 1377	SO_3	1
	Ca SO_4 / $2H_2O$	3
Carbonates NF P 15–461	SO_4	1
Chlorures méthode de MOHR	NaOH	10
	NaCl	1

X-ray diffraction (XRD)

The Mineralogical analysis of Clay was made with the aid of the x-ray diffraction (XRD). This technique allows you to identify the crystalline phases present in this Clay and determine the parameters of mesh associated. These applications are possible thanks to the interference of X-rays with the matter.

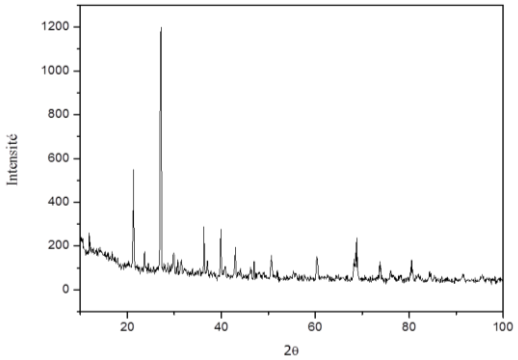

Figure 3. Diffractometric analyses of El Hadjira clay.

We note that the clay sample consists essentially of quartz and Montmorillonite associated minerals, as well as Bentonite.

II.2. Gravel

Gravel has origins similar to those of a sac rushed sand and, it comes from the disintegration of rocks. The maximum size of the aggregates is determined, on the one hand, by the minimum distance to be achieved and, on the other hand, by the minimum distance between the various reinforcements of the structure. The 3/8 fraction is considered as.

Figure 4. Gravels of Ouargla.

The results obtained are as follows:

Table 3. Physical characteristics of gravels.

Test	classe 3/8	classe 8/15
The absolute density (kg/m^3)	2613	2661
The apparent density (kg/m^3)	1506	1460
Micro-Deval Test	10	11.2
Los Angeles Test	20	25

III.Results and Interpretations

The experimental study of our work consists in determining the thermal and mechanical characteristics of the Adobe based on local materials of dimensions (7x 7 x28) cm ,then different tests were carried out on the made samples. These tests are carried out at University of Ouargla ,Civil Engineering Laboratory, under the following conditions: Temperature (30 ± 5°C), and relative humidity RH= 35 ± 3%.

We proposed for our work the following five compositions (clay + gravel (3/8 and 8/15) + lime):

Table 4. Used compositions based on Adobes Treated by Lime.

	Ch 0	Ch 1	Ch 2	Ch 3	Ch 4	Ch 5
clay %	50	49	48	47	46	45
Gravel 8/15 %	10	10	10	10	10	10
Gravel 3/8 %	40	40	40	40	40	40
Lime%	00	01	02	03	04	05

- **The reference composition: C0: 50% clay +10% gravel (8/15) +40% gravel (3/8).**

The following four histograms are displayed gives Figure:
- Shows the variation of the density of Adobes according to the different percentages of lime.
- The results of the compressive resistance.
- Results of flexural resistance.
- Results of sound speed.

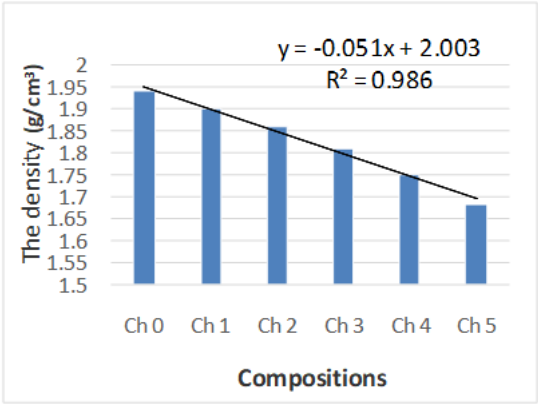

Figure 4. The variation of density of Adobes (g/cm^3).

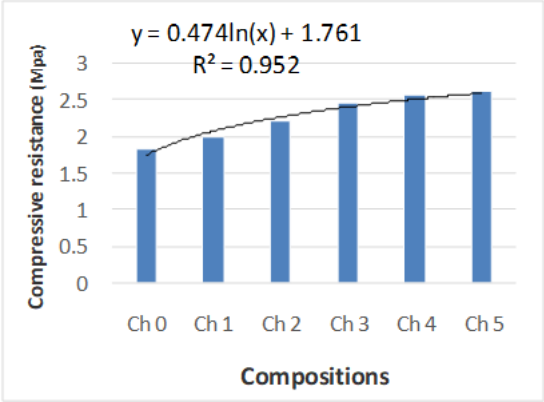

Figure 5. The variation of compressive resistance (MPa).

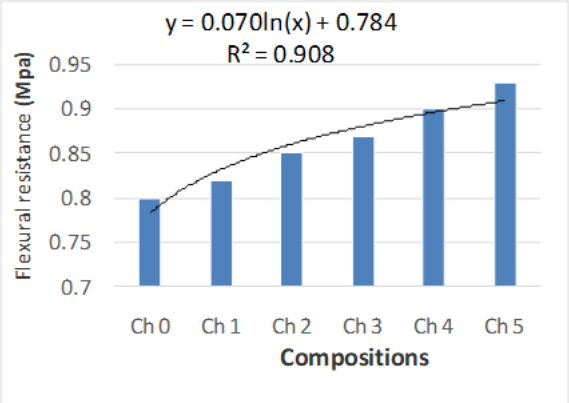

Figure 6. The variation of flexural resistance (MPa).

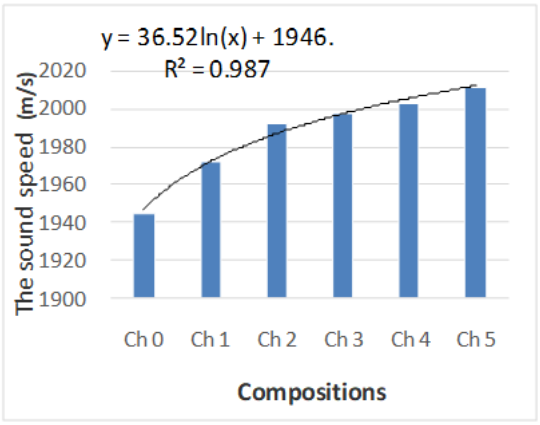

Figure 6. The variation of sound speed (m/s).

According to the experimentation one notices:

- Note on curve (1) that the values are decreasing, and this is a return because the density of the clay is greater than the density of the lime.
- The addition of lime gives a positive influence from a mechanical point of view (compression and bending).
- The compressive strength of Sample Ch5 has increased up to 43% compared to the reference sample Ch0.
- The Ch5 composition gives better results.
- The test of the speed of sound confirmed the results of the mechanical tests (compressive and flexural strength).

The three following histograms are displayed gives Figure:
Shows the variation of the thermal properties of Adobes according to the different percentages of Lime.

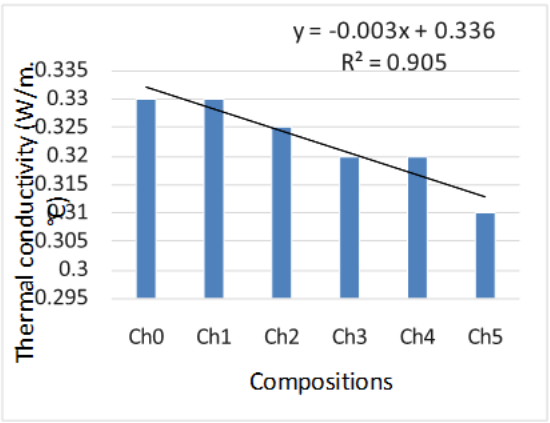

Figure 7. The variation of Thermal conductivity (W/m. °C).

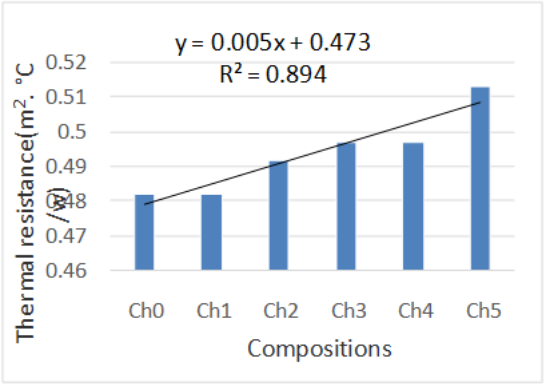

Figure 8. The variation of Thermal resistance (m2. °C /W).

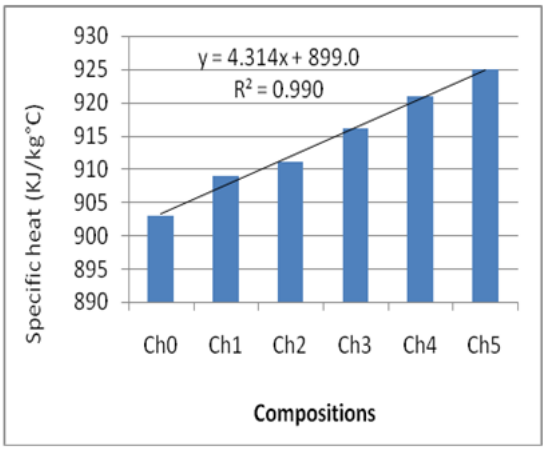

Figure 9. The variation of Specific heat (KJ/kg°C).

According to the experimentation one notices:

- A convergence of the thermal results.
- The treatment of Adobe with lime gives a positive influence from a mechanical point of view, but does not influence the thermal side.
- The thermal resistance is almost stable in spite of the increase of the percentage of lime.
- The samples generally give a good thermal behavior.

IV. Conclusion

According to the experimental study on the thermal and mechanical properties of different compositions, the following conclusions can be drawn:

The influence of the addition of stabilizer results in a lighter Adobe and better thermal and mechanical performance. The compressive strength of Adobe increases up to 43% compared to the reference sample in the case of Lime Treatment.

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