Study of the characteristics of mud bricks reinforced with plastic polymer

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***Abstract* —with the enormous development of human life and increase in energy consumption, new challenges are facing this high consumption, particularly with the climate changes affecting our desert regions, in particular the State of Ouargla, one of the hottest regions in Algeria especially in summer.**

In this challenging context, this work continues in research axes aimed at creation better building materials, with better thermal and mechanical properties, from which we seek in the characterization of new plastic process and earth bricks. In this sense we study the thermal and mechanical behaviour of bricks based on local materials and ecology (Case: Ouargla region) such as clay and sand dunes, this composition is where each composition is subjected to a set of thermal (conductivity) and mechanical (compressive strength, tensile strength, sonic propagation speed). The results show an overall negative effect in the sense of physico – mechanical.

Keywords—**bricks, clay, dune sand, plastic, polymer, mechanical properties.**

I. INTRODUCTION

The climate in southern Algeria is warm in summer, where the building needs to be comforted by increasing consumption of emarginate materials.

The context of this work in a continuation in a research axis of the creation of building materials with better thermal and mechanical properties, from which we seek in the characterization of new earth bricks, and given the importance of polymer in the world, and the great success of valorization of this type of materials in the road filed (polymer modified bitumen, geosynthetics and geogrid, …etc.) we are looking for the possibility to develop in the construction field.

In this sense, we will study a brick made of two local materials: namely clay and dune sand with plastic waste as an addition. The composition reinforced with plastic materials in different proportions, from which each position is subjected a physical and mechanical test (Bulk density, Compressive strength, Tensile strength). [1]

II. MATERIALS AND METHODS

A. . Clay

For the research needs, we used Touggourt clay from Ouargla city, where the clay performed to the following tests:

- Water content;
- Dry density;
- Methylene blue;
- Atterberg boundary;
- Granulometric analysis by sedimentation;
- Summary chemical analysis.

The tests are carried out at the Southern Public Works Laboratory (L.T.P.S) in Ghardaïa. The results are presented in Table 1. [2]

TABLE 1. CLAY TEST RESULTS.

FEATURES & CHARACTERISTICS		**RESULTS**
Water content (NF P 94-050)		2.83
Bulk density (NF P 94-064)		1.71 g/cc
Bleu methylene value (NF P 94-068)		3.77 %
Atterberg's limits (NF P94-051)		WL= 63.9%. WP = 32.69%. IP = 31.21%.
Chemical Analysis	Insoluble	72.7 %
	Sulphate SO_3^{-2}	1.61 %
	Carbonate $CaCO_3$	20 %

In this type of materials, the granular distribution determined by two methods, dry after washing in the sieve 0.08mm to separate the fine particles (Figure 1), then continues the identification of the diameters of particles using the sedimentation method, the operation method used the follow instruction of NF P 97 – 057 standards based on the measurement of the density variation by densitometer.

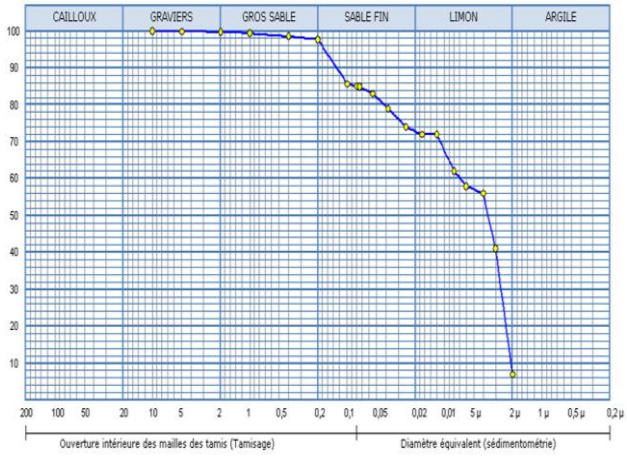

Figure 1. Dry particle size analysis after washing (NF P 94-056)

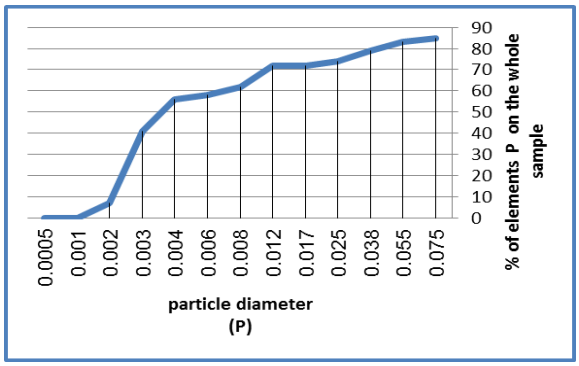

Figure 2. Particle size analysis by sedimentation (NF P 94-057)

B. *The sand dunes*

For our study, we used the sand dunes of Sidi – Khouiled (Ouargla). We performed the following test

- The absolute density;
- The bulk density;
- Sand equivalent;
- Granulometric analysis by sedimentation;
- Methylene blue;
- Summary chemical analysis.

These tests are carried out at the Southern Publics Works Laboratory (L.T.P.S) at Ghardaïa, the results are presented in Table 2. [3]

TABLE 2. PHYSICAL CHARACTERISTICS OF DUNE SAND.

FEATURES & CHARACTERISTICS		**RESULT**
THE ABSOLUTE DENSITY		ρ = 2.63 g/cc
SAND EQUIVALENT		ES = 83 %
METHYLENE BLUE		VB = 0.025 %
CHEMICAL ANALYSIS	Insoluble	94 %
	Sulphate SO_3^{-2}	02 %
	Carbonate $CaCO_3$	00 %

More tests we also tested the distribution granulometric analysis, the results expressed by a curve expresses the granular distribution by the percentage of passing of each particle diameter.

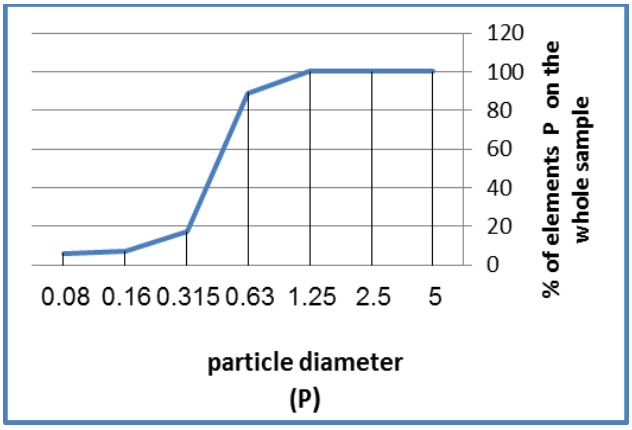

Figure 2. Granular distribution of used dune sand

C. *Plastic material.*

For our study we used the high-density polyethylene (HDPE) of the company U.T.P.S located in the wilaya of Ouargla, this polymer has a round shape (figure 03) without the presence of light color (transparent), these polymers are subjected to thermal analyses at the polymer laboratory level of the University of Bejaia, the experimental plan for this point contains two tests:

- Thermogravimetry analysis (ATG);
- Differential thermal analysis (DTA).

Figure 3. High-density Polyethylene used.

The thermogravimetric (ATG) and thermogravimetric derivative (DTG) analysis test, first consist of measuring the mass change over time with the temperature change, the ATG curve is presented in Figure 4. The second test is really effective in detecting the first derivative of ATG curve, from which it can detect small records (Figure 5)

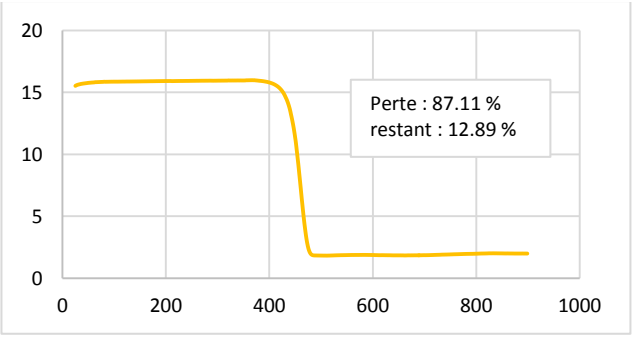

Figure 4. ATG Curve of High-density Polyethylene used.

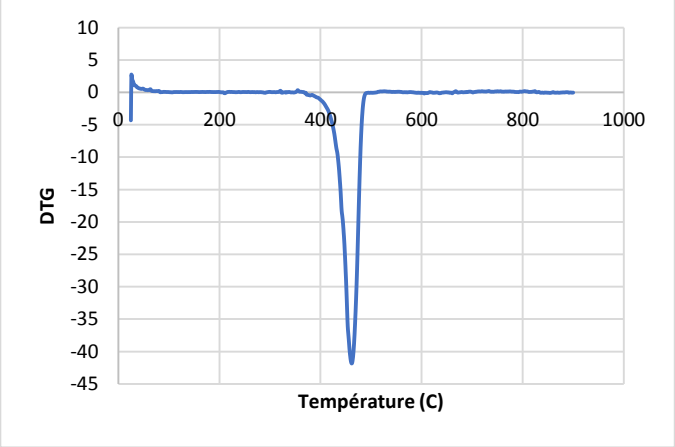

Figure 5. DTG Curve of High-density Polyethylene used.

In order to verify the thermal behaviour of our polymer, we used a thermogravimetric analysis (ATG) coupled with a differential thermal analysis (ATD) showed in the figures bellows which shows the polymer sample begins to loss mass from a temperature of 375ºC. And the loss is localized in zone 375 at 475ºC is attributed in literature to the emission of gas such as H_2, CH_4, CO/CO2.

The first derivative (Figure 5) for ATD/ATG curve shows maximum decomposition at 441ºC after degradation, the polymer sample leaves a carbon residue of approximately 12.89% of its initial mass at 800ºC.

III. Results and Discussion

We have prepared four types of mixes, the baked brick co mpositions used are shown in Table 3.

TABLE3. BAKED BRICK COMPOSITION.

	C1	C2	C3	C4
Clay (%)	70	69	68	67
Dune sand (%)	30	30	30	30
plastic (%)	0	1	2	3

Each composition is fabricated in laboratory on three specimens of dimension 04 x 04 x 16 cm^3, the specimens are stored for 07 days at room temperature before demouling, and carried out a plan of physical – mechanical tests consists of

- The bulk density;
- Tensile strength by bending;
- Compressive strength;

A. *Bulk density*

The bulk density measurement carried out geometrically, using the capillary, the next figure shows the variation in the bulk density of the bricks in function of HDPE ratio. [4]

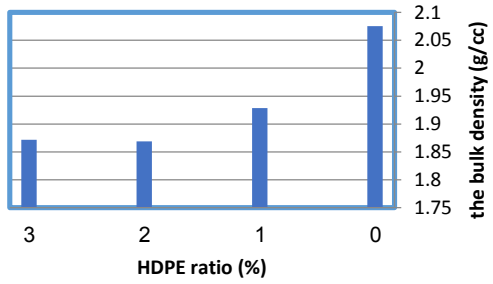

Figure 6. The bulk density as a function of the HDPE ratio.

B. *Tensile strength test*

The tensile strength of a brick is determined according to standard NF P 18 – 407 by a three – point bending device. The distance between the two point supports the specimens is 104 mm. The next figure belows shows the influence of polyethylene on the tensile strength. [5]

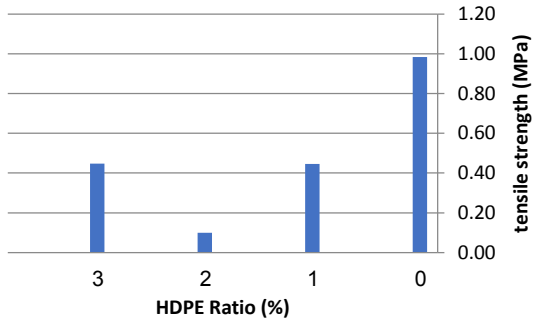

Figure 7. The tensile strength as a function of the HDPE ratio.

C. *Compressive strength test*

For this test consists in applying the compressive forces on cublic specimens of 04 x 04 x 04 cm3 to determine the compressive strength, in our case we carry out on the semi – brick specimens after the tensile bending test [7].

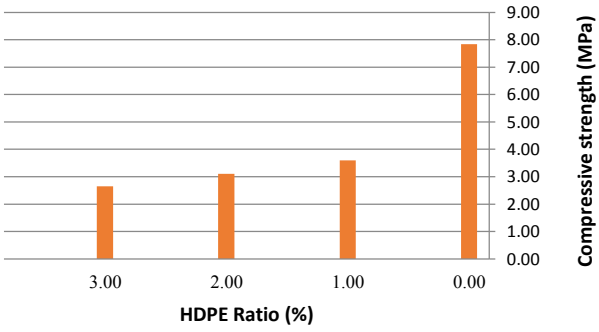

Figure 08. Compressive strength on mud bricks.

IV. Conclusion.

After the experiment, we drew following conclusion:

It can be seen that the addition of this type of polymer with this shape (round), does not offer an improvement in the density, the significant difference in absolute density between polymers (0.94 to 0.98 g/cc), where the specific density of polymer is 2.5 to 2.7 g/cc; which caused a drop in the density value.

The results show that negative impact of this polymer with this form are not only observed in the density, but also in the tensile strength, the new brick has fallen by 89 % for 2 % HDPE, and 54 % for 01 and 03 %. The cause is the lack of cohesion between the polymer and the aggregates, this lack is noticed after the crushing, the plastic particles is not deformed or crushed which means is doesn't collaborate is the resistance.

And as long as the absence of adhesion between the particles and materials doesn't resist compressive stress as well, the decrease is resistance varies from 54 % to 66 % for 01 to 03 % respectively. [7]

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