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The Effect of Adding Sawdust to a Compressed Earth Block Composed of Lime and Clay

A. Fidjah [1], M. Rabehi [2], C. Kezrane [1] , M. Omrane [3], M. Latrache [4], A. Deliou [5], A. Oudrane [6], H. Mezaache [7]

[1]*Mechanics and Materials Development Laboratory (LDMM) - University of Djelfa, 17000, Algeria.*
[2] *Department of Civil Engineering, University of Djelfa, 17000 Djelfa, Algeria.*
[3] *Applied Automation and Industrial Diagnostics Laboratory, University of Djelfa 17000 DZ,*
[4]*Faculty of Mechanical Engineering, Mohamed Boudiaf University of M'sila.*
[5]*Department of Mechanics University Med Seddik Benyahia (UMSB de Jijiel), Algeria.*
[6] *Faculty of Science and Technology. Ahmed Draïa University of Adrar, Algeria 01000.Sustainable Development and Computer Science Laboratory (LDDI).*
[7] *Soils and Hydraulics Research Laboratory, Badji Mokhtar-Annaba University, BP12, 23000, Annaba, Algeria. .*

***Corresponding author:** fidjah.abdelkader@gmail.com*

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Abstract. The countries of the world paid attention to the environment and its concept was related to sustainable development, renewable and clean energy was used instead of traditional energy that polluted the ocean.
Ecological materials are one of the solutions used in sustainable development, Compact earth bricks are well-known eco-materials, in this context, we are carrying out a study on bricks made of lime and clay 20*10*05 cm pressed by hydraulic machine, we mix the two components in different proportions to find the best sample in terms of hardness, we add 1%- 20% sawdust for the best sample, we conduct other experiments on the samples to find out the effect of adding sawdust on the compound, we study some mechanical properties of the strongest sample, the results show that adding sawdust increases the hardness by 21%, reduces density by 2.07%, increases Young's modulus by 45% and decreases thermal conductivity by 12%. This indicates the positive effect of adding lime and sawdust to the compressed earth block.

Keywords. Ecological materials, Block of compressed earth, Mechanical properties**.**

INTRODUCTION

Building materials have an impact on the climate and the environment (Feraille et al., 2022), countries and societies have taken an interest in creating environmentally friendly buildings by using natural materials, these materials comply with environmental standards as being a natural, renewable and sustainable resource (Jammoukh et al., 2017), its manufacture does not produce greenhouse gasses and does not cause any damage to the environment; recyclable, it consumes little energy and has no effect on health (Escadeillas, 2006).

Clay and lime are two abundant materials in southern Algeria, they are both known to be environmentally friendly materials.

In this study we are going to discover the natural bricks composed of these two materials We add different percentages to the samples of the sawdust, the purpose of the experiments is to know the positive effect of the addition of sawdust in the block of compressed earth made up of lime and clay (Avamasse et al., 2011), and knowledge of certain mechanical properties of the ideal sample.

MATERIALS AND METHOD

Clay

Clay used is from the city of Adrar which consists of : SiO_2 + Al_2O_3 + Fe_2O_3+ CaO+ MgO with 95.92%, $CaCO_3$ in 3.6%, Cl^- in 0.14% and SO_4 in 0.41% with density 2.6 g/cm^3 (Mohammed et al., 2018).

Lime

Lime used is from the region of Ghardaïa with density 0.93 g/cm^3 (Table 1).

Table 1. Chemical composition of the lime used.

Element	CaO	MgO	SiO_2	Al_2O_3	FeO_3
Percentage (%)	56	42	0.4	0.04	0.08

Sawdust

Sawdust used is from the carpentry process with density 0.104 g/cm^3 (Benyoucef and Harrache, 2015) (Table 2).

Table 2.Chemical composition of sawdust.

Element	Cellulose	Hemicellulose	Lignin
Percentage (%)	39.7	26.9	25.4

Clay is mixed with lime according to the following principle (Table 3):

- Pellet size less than 02 millimeters.

The weight of the mixture while dry is 02 kg

- Mix the compound with an electric mixer for 03 minutes.
- Add 250 cl of water, then mix for 02 minutes.
- The mixture is placed in a metal mold of dimensions 20*10*10 cm^3 and a pressure of 2.5 MPa is applied.

As a consequence, we are left with a brick that is 20*10*05 cm^3. They take 28 days to dry.

- After determining the mass and volume, determine the density (Fig. 1).

Table 3. Sample preparation.

Clay (%)	Lime (%)	Samples
90	10	A90C10
80	20	A80C20
70	30	A70C30
60	40	A60C40
50	50	A50C50
40	60	A40C60
30	70	A30C70
20	80	A20C80
10	90	A10C90

- To determine the samples' hardness, we apply pressure.
- We employ a hydraulic pressure apparatus with a reading screen similar to figure 2.

The experiment results revealed that sample A60C40 has the highest hardness. Following this result: Sawdust is added to this sample with a different percentage 01%, 02%, 03%, 04%, 05%, 06%, 07% and 12% 20%. The samples are represented by symbols in the following order: A60C40 SB01%. A60C40 SB02%. A60C40 SB03%. A60C40 SB04%. A60C40 SB05%. A60C40 SB06%. A60C40 SB07%. A60C40 SB12%. A60C40 SB20%.

The same experiments are run under identical circumstances, including mixing and drying times. In terms of hardness, we discover that the A60C40 SB04% sample is the best. Then determine the sample's thermal conductivity and Young's modulus.

RESULTS AND DISCUSSION

By adjusting the lime and clay ratios, the density value changes. The density reduces as the percentage of lime rises (Cabane, 2004) (Fig.1).

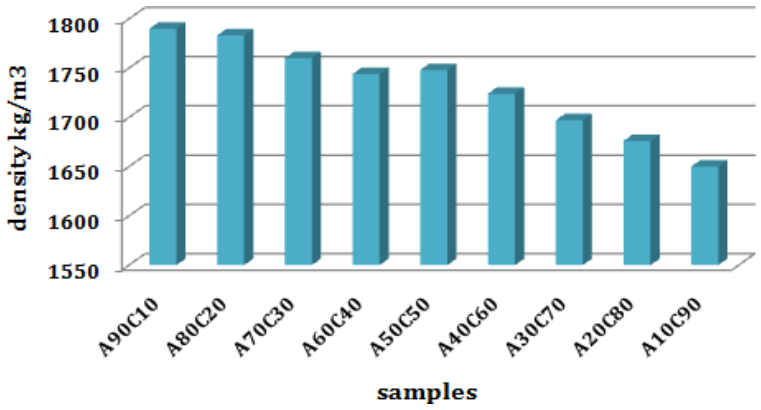

Fig.1. Density measurement results.

The pressure force needed to break the bricks climbs by up to 40% of lime (Saadi, 2017) (Fig.2), when the amount of lime is increased before starting to decline when lime is added. The brick becomes harder as the compressive strength rises (Djamila et al., 2019).

Density changes in sample A60C40 when sawdust is added (Fig.2). As the percentage of sawdust rises, density falls (Chemani and Chemani, 2013) (Fig.3).

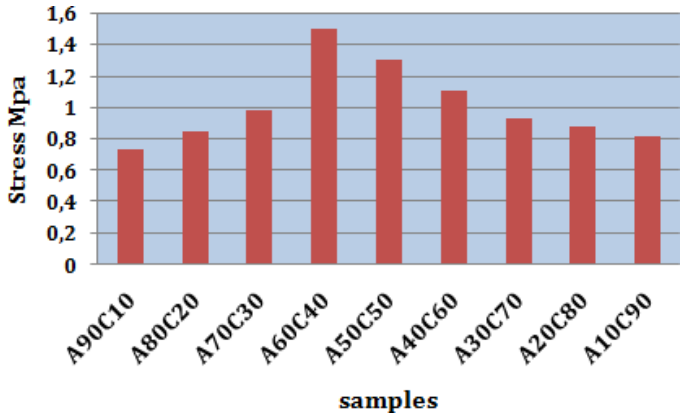

Fig.2. The evolution of the value of the stresses according to the proportion of lime and clay.

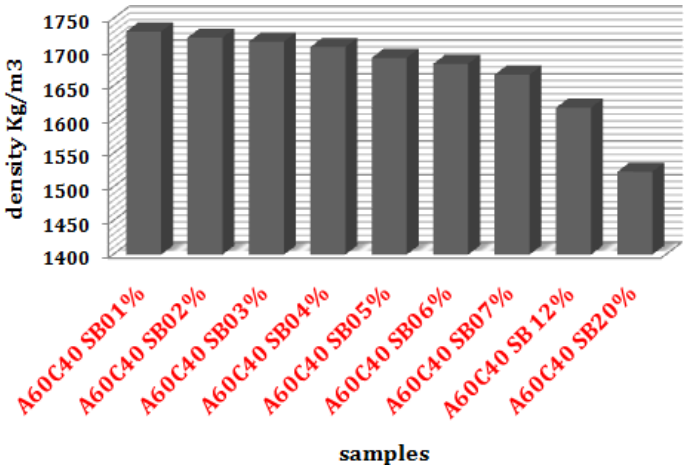

Fig.3. Changes in density depending on the percentage of sawdust.

The bricks get lighter as the density goes down (Benjeddou et al., 2018). Density falls by 0.75 percent. 1.26% 1.16% 2.06% 2.98% 3.5% 4.41%, 7.22%, and 12%, based on the ratios 12%, 20%, 12%, 12%, 01%, 02%, 03%, 4%, 5%, 6%, and 7% in that order.

The stress value rises when sawdust is added to the A60C40 sample (Fig.4). Bricks' compressive strength is increased when sawdust is added gradually (Sun et al., 2018). As sawdust is added, the stress value rises from 0% to 4% before falling. Increased by 13% for every 1%. 08% for 02%. 18% for 03% 17% for 05% and 21% for 04% 12% for 06%. reducing percentages: 0% for 7%, 18% for 12%, 44% for 20%.

By using significant quantities of sawdust, the resistance of the bricks is reduced (Benjeddou et al., 2018). The hardest sample is A60C40SB04% with 4% sawdust.

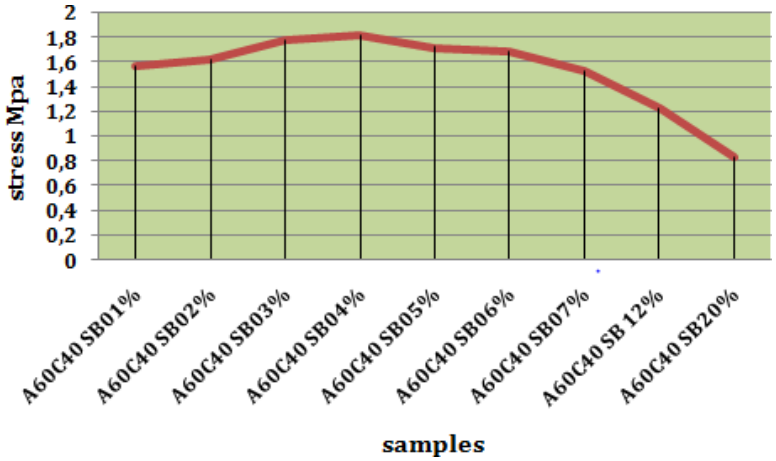

Fig.4. Change in stress value with the addition of sawdust.

Figure 5 displays the results of the thermal conductivity and Young's modulus prior to and following the addition of sawdust.

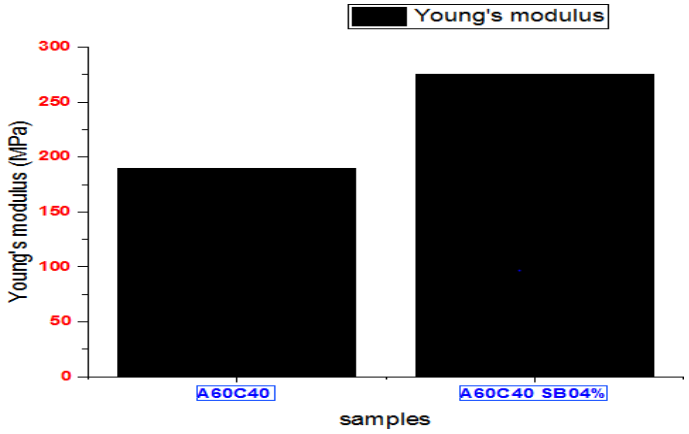

Fig. 5. Young's modulus in sample A60C40 before and after adding sawdust..

After the addition of sawdust, the sample's Young's modulus rises from 190 MPa to 275 MPa by 45 percent. Bricks are more resistant to breaking when exposed to sawdust (Cultrone et al., 2020). Adding sawdust causes a 12% drop in heat conductivity. Bricks with more sawdust have better thermal insulation (Charai et al., 2020) (Fig.5).

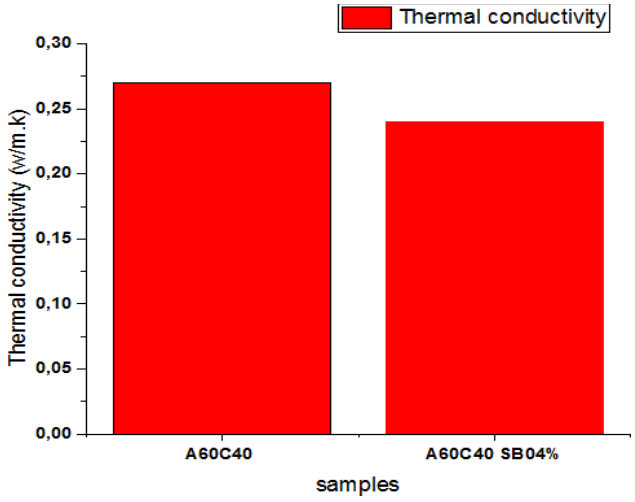

Fig.6. Thermal conductivity in sample A60C40 before and after adding sawdust.

CONCLUSION

Ecological materials have a positive effect on construction (Deboucha and Hashim, 2011). They are good insulators for heat and humidity, it also reduces the energy costs of air conditioners (Topçu and Işıkdağ, 2007).

In this study, the experience explains why adding lime to the clay has a favorable effect since we get bricks that are more resistant to breaking when we combine 60% clay and 40% lime.

The effect of adding sawdust to the compacted earth block is explained, it is noted that 04% of sawdust increases the hardness by 21%. This makes the bricks resistant to breakage, and increases the modulus of elasticity of the material 45%.

The density is reduced by 02%, the brick becomes lighter, and the thermal conductivity decreases by 12%, which gives the bricks the ability to resist heat and heat exchange.

the disadvantages of clay bricks, it is not resistant to water and climatic factors and fades over time (Hossain, 2015).

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