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Research Article

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Building Materials: Application with Mixtures of Clay and Cement

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Abstract The aim of this study is to improve the proprieties of the clay. Thus, we conduct this study related to the mixtures of clay and cement for their use as building material. The clay formations represent an abundant economical materials resource available in tropical and equatorial Africa. We have determined by experiments the mechanical and thermal properties of cement modified clay specimens. This work enabled us to determine the optimal blend according to their thermo-mechanical properties. The interesting results obtained show that the integration of mixtures of clay and cement in building materials are great opportunities to reduce the cost of social housing. It also improves the thermal comfort.

Keywords Cement, Clay, Mechanical properties, Mixture, Thermal properties

Introduction

Local soil is used economically on the spot for millennia. More than 30% of the population habitats worldwide are made of soil. Whether raw, cooked or stabilized, varieties of earthen architectures have abounded since the appearance of humans throughout the world [1].

The range of materials used in the habitat is relatively large. But, due to the high cost of construction materials, it is possible to make simple disposition in order to decrease the cost of construction.

In Africa, earthen construction has become over the years an art: For example, cases-shells in Cameroon or the pyramids in Egypt.

The soil is generally used in laterite or clay states and which represent the most abundant and economical materials resources in Africa. The clay is easily available in the open country [2].

Thus, to improve the proprieties of the clay its interesting to mix it with cement. The cement that was used is an hydraulic binder. It is the product obtained by reducing clinker powder consisting essentially of hydraulic calcium silicates and a small quantity of gypsum (hydrated calcium sulphate). Gypsum is a mineral used to delay and regulate the taking and hardening of cement [3 - 4]. The resistance to compression of materials is one of the properties used in the design of buildings.

The thermal resistance of a material gives it certain insulation depending on its thickness and this resistance is inversely proportional to the coefficient of thermal conductivity. Thus, the main objective of this research is to optimize the properties of cement mixed with clay for possible use in building construction.

Materials and Methods

The clay we used to make our samples comes from Sebikotane town located at 40 km from Dakar (Senegal)

The sieve and sedimentation analysis of this clay soil show 3% of coarse sand, 24% of fine sand, 15% of silt, 58% of clay and 90% of the grains mass pass the sieve 80 µm (Figure-1).

Thus, the effects of particle size distribution on the behaviour of soil are not very important [5 - 6].

The cement that was used to improve our samples is CEM I 42.5 cement from SOCOCIM in Rufisque, a town 20 km from Dakar, Senegal.

We used a hydraulic press to perform compression strength tests [7 - 10].
We used the boxes method to perform thermal conductivity tests [11 - 14].

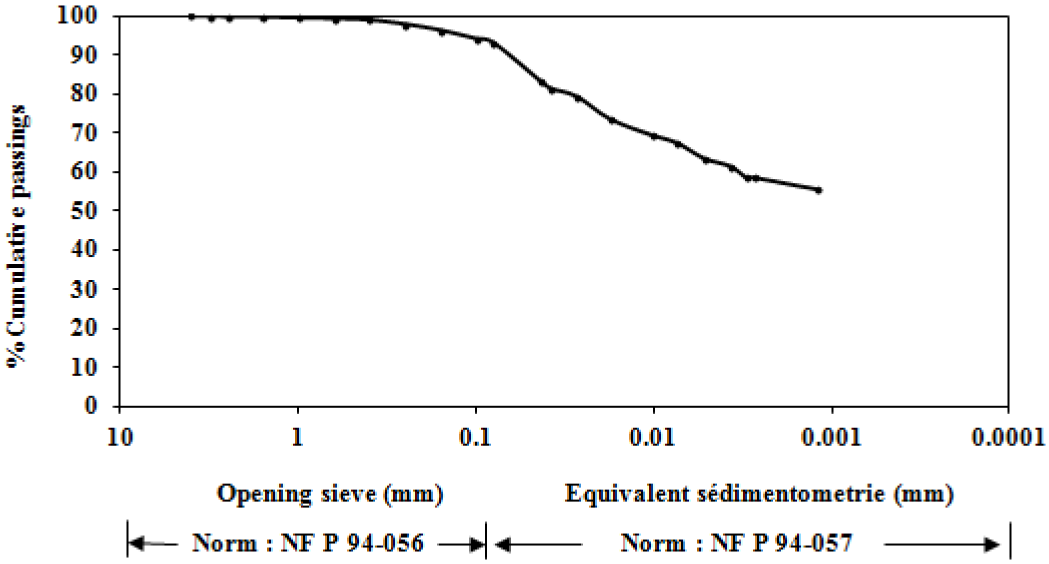

Figure 1: Size analysis and sedimentation analysis of Sebikotane's clay

Results & Discussion

Mechanical Characterization

Figure 2 shows the results of compression strength of cement mixed with the clay after 28 days of cure. This Figure 2 shows that the compressive strength increases according the percentage of the cement

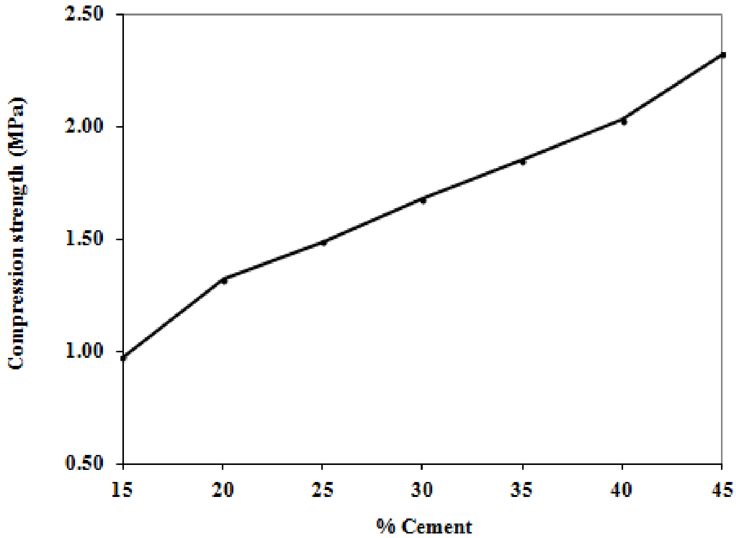

Figure 2: Evolution of the compression strength according to the percentage of cement mixed with the clay after 28 days of cure

Thermal characterization

Figure 3 shows the results of thermal conductivity of cement mixed with the clay after 28 days of cure.
This Figure 3 shows that the thermal conductivity increases according to the percentage of cement.
Figure 4 shows the results of thermal resistance according to the percentage of cement mixed with the clay for a wall thickness of 20 cm after 28 days of cure.

This Figure 4 shows that the thermal resistance decreases according to the percentage of cement. Furthermore, it is important to note from 45% the material becomes less economical

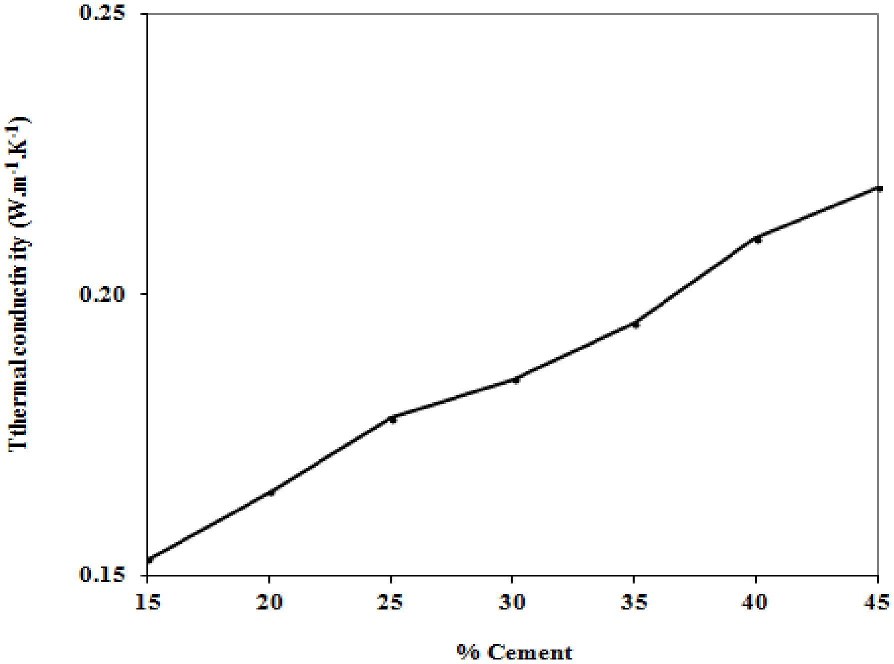

Figure 3: Evolution of the thermal conductivity according to the percentage of cement mixed with the clay after 28 days of cure

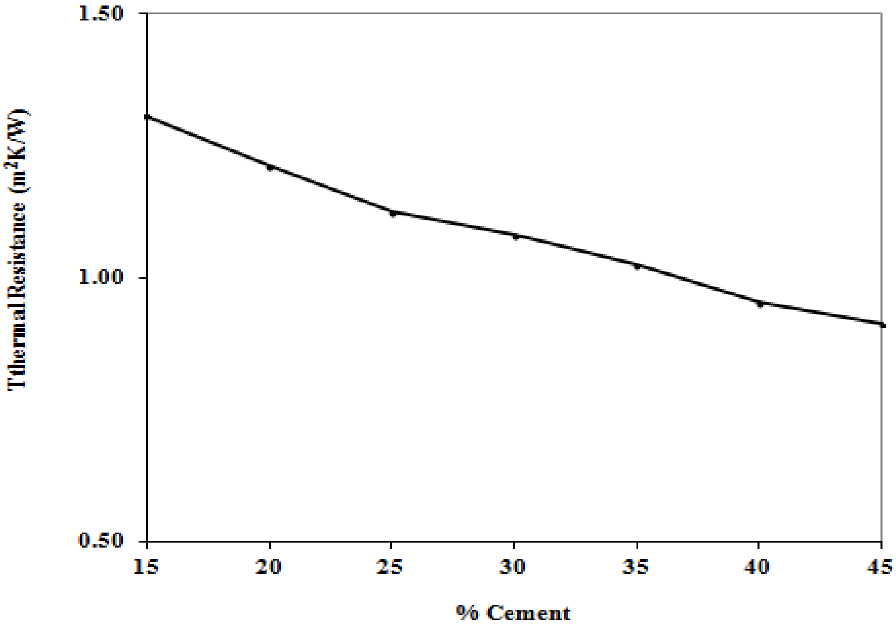

Figure 4: Evolution of thermal resistance according to the percentage of cement mixed with the clay for a wall thickness of 20 cm after 28 days of cure

Thermal-mechanical results

To have in parallel the mechanical and thermal characteristics, we represented them in Figure 5.

This Figure 5 shows that the optimal mixture is composed of 30% of cement and 70% of clay.

This optimal mixture has a thermal resistance of 1.081 m^2K/W, for a wall thickness of 20 cm, and a compressive strength of 1.677 MPa.

However, in order to justify this choice of optimal mixture, we can calculate the minimum mechanical strength we need to build a non-bearing wall with this material.

If we consider a 4 m high non-bearing wall built with this optimal composition of 1351 kg/m^3 density.

The base of the wall must have at least 0.054 MPa compression strength. This is much lower than the mechanical compression strength of the optimal formulation.

This optimal mixture has a good thermal resistance and a mechanical resistance to the compression, which is above what is required for a filling wall of a building.

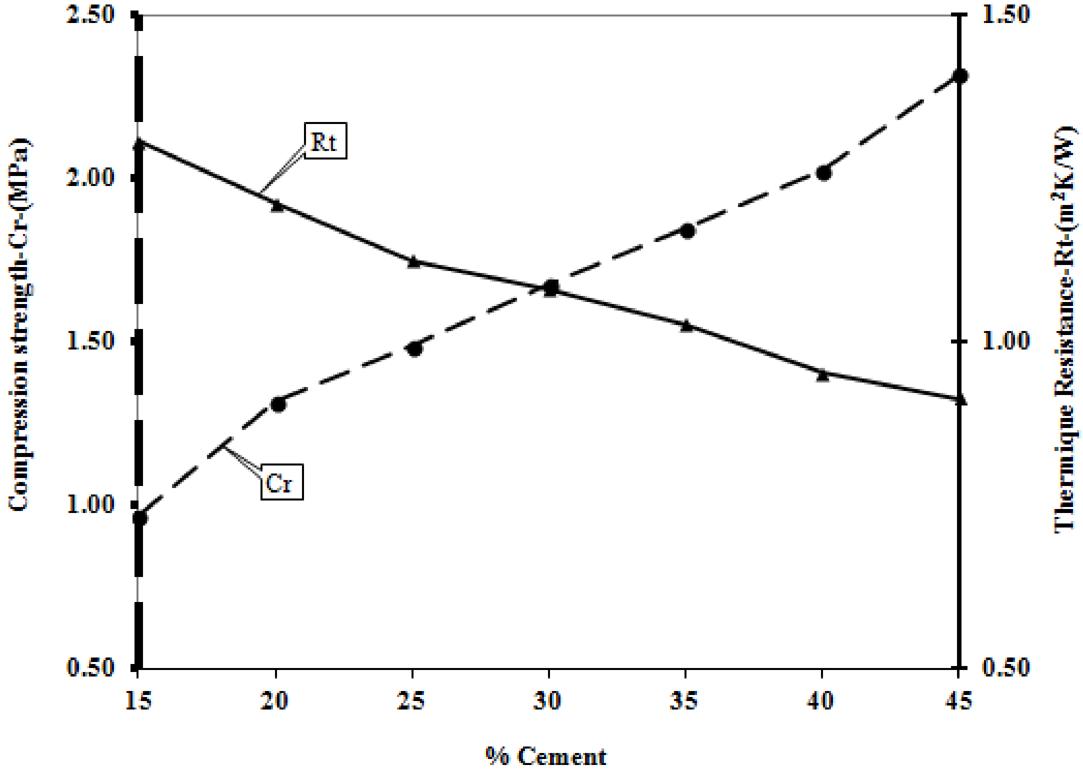

Figure 5: Evolution of compression strength and thermal resistance according to the percentage of cement mixed with clay for a wall thickness of 20 cm after 28 days of cure

Conclusion

At the end of our work, we note that:

- Proceeding to mixtures of cement with Sebikotan's clay, we were able to optimize the thermo-mechanical properties of materials.
- The optimal mixture is composed of 30% of cement and 70% of clay.
- The optimal mixture has a compression strength of 1.677 MPa and a thermal resistance of 1.081 m^2K/W.

Finally, the interesting results obtained allow to reduce the cost of social housing and to improve thermal comfort.

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