LATERITE IN BUILDING MATERIALS

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Abstract - The main objective of this study is to comparethe properties of the laterite mixing with rice straw and with cement for building materials. The discomfort in buildings, caused by rising temperatures, is a major problem that requires relevant responses according thermo-mechanical resistances of construction materials. The laterite formations represent an abundant economical material resource available in tropical and equatorial Africa. The rice straw is an agriculture waste. The cement is a hydraulic binder. The Interesting results obtained show that the integration of rice straw in building materials improves the thermal comfort and recycles the straw. The integration of cement in building materials improves the compression strength. The comparison ofthe performances of samples makes it possible to indicate the best materials and to propose new building materials based on their thermo-mechanical properties.

Keywords - Building materials, cement, compare, rice straw waste, thermo-mechanical properties

I. INTRODUCTION

Senegal naturally benefits from a climate which is not lenient inside houses in terms of heat, almost all year round. That's way populations resort to cooling devices, which generates high energy costs. So, the range of materials used in the habitat is relatively large according thermo-mechanical properties. Also, due to the high cost of construction materials, it is possible to make simple disposition toimprove thermal comfort and decrease the cost of construction while maintaining good mechanical resistance [1]. The soil is the oldest material of construction used economically on the spot for millennia, in a mixture form of clay, gravel, sand and silt. More than 30 % of the worldwide population habitats are made of soil. Whether raw, cooked, army of straw or otherwise stabilized. The varieties of earthen architectures abound since the appearance of humans throughout the world [2-3]. Rice straw is rich in cellulose. Consequently, only animals able of digesting cellulose (rabbit, horse, etc.) use it as food. The majority is lost, buried, burned, or used as bedding [4]. The Portland cement 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 [5-6]. The thermal resistance of a material gives it a certain insulating depending on its thickness, and this resistance is particularly inversely proportional to the coefficient of thermal conductivity. Also, the resistance to compression of materials is one of the properties used in the design of buildings.
Thus, in this research we show how to optimise and compare the mechanical and thermal properties of mixtures materials. After comparing we propose new materials for possible use in building materials.

II. MATERIALS AND METHODS

The laterite comes from Montrolland, town located at 87 km from Dakar (Senegal). We considered the fraction of the laterite passing the 5 mm sieve to make our samples [7].
The straw, variety Sahel 108, comes from Dagana, town located at 408 km from Dakar (Senegal).
The cement that was used to improve our samples is the CEM I 42.5 Portland cement from SOCOCIM in Rufisque, a town located at 20 km from Dakar, Senegal.
We used:

- The particle size analysis that processes the identification for the classification of a material from the grain size [8-10].
- The hydraulic press to perform compression strength tests [11-13].
- The boxes method to perform thermal conductivity tests [14-16].

III. RESULTS AND DISCUSSION

3.1. Particle size analysis

The size analysis of this laterite soil shows 25% of gravel, 15% of coarse sand, 25% of fine sand, 6% of silt, 29 % of clay and 52 % of the grains mass pass the 80 μm sieve (Fig.1).
Thus, the effects of particle size distribution on the behavior of lateritic soil are important[8].

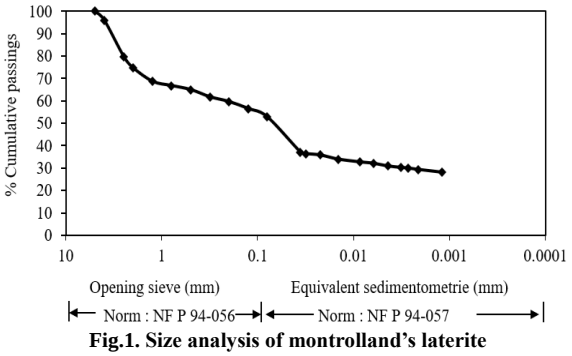


Fig.1. Size analysis of montrolland's laterite

3.2. Mechanical characterization

For the mixtures of laterite and straw, the Fig.2. shows an increase in compressive strength as a function of the percentage of strawfrom 1% to 4% in the mixture.

It is important to note that from 4% of straw, the mixing of mixtures is almost impossible. Therefore, the straw helps to reinforce the skeleton of the laterite.

Forthe mixtures of laterite and cement, the Fig.2. shows also an increase in compressive strength as function of the percentage of cementfrom 15% to 30% in the mixture.Therefore, the cement helps to reinforce the skeleton of the laterite.

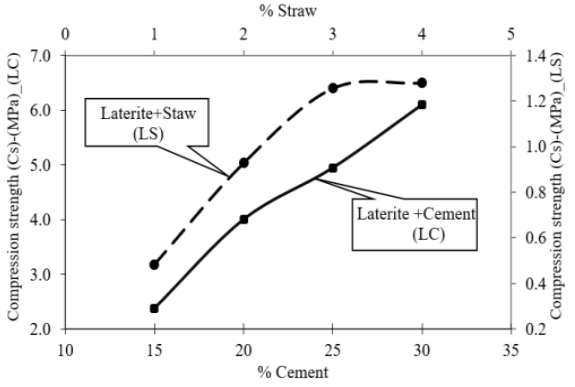


Fig.2. Evolution of compression strength according to the percentage of straw mixed with laterite and according to the percentage of cement mixed with laterite.

3.3. Thermal characterization

For the laterite mixed with the straw, the Fig.3. shows that the thermal conductivity decreases according to the percentage of strawfrom 1% to 4% in the mixture. For the laterite mixed with the cement, the Fig.3. showsthat the thermal conductivity increases according to the percentage of cementfrom 16.67% to 28.57% in the mixture.

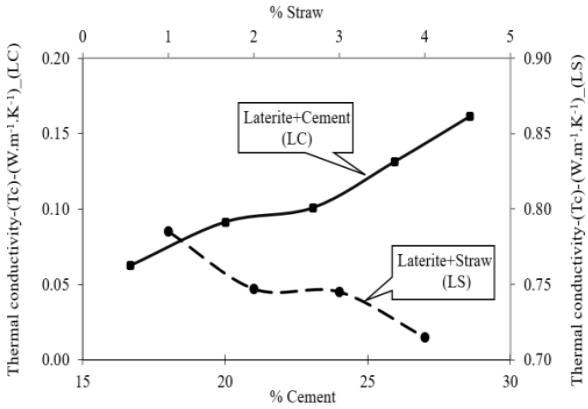


Fig.3. Evolution of thermal conductivity according to the percentage of straw mixed with laterite and according to the percentage of cement mixed with laterite.

With the Fig.4., we have the evolution of thermal resistance based on the percentage of the straw mixed with the laterite and based on the percentage of the cement mixed with the laterite, for wall thickness of 20 cm. We note that, the thermal resistance of the laterite mixed with the straw increases as a function of the percentage of straw added, from 1% to 4%.

We also note that, the thermal resistance of the laterite mixed with the cement decreases as a function of the percentage of cement added, from 16.67% to 28.57% in the mixture. Thus, the straw has a thermal conductivity lower than that of the laterite. So, it appears that the straw only is an excellent thermal insulation. This confirms the importance of the thermal insulation when designing a straw bale house: wood-frame with a filling straw (technique known as Austrian).

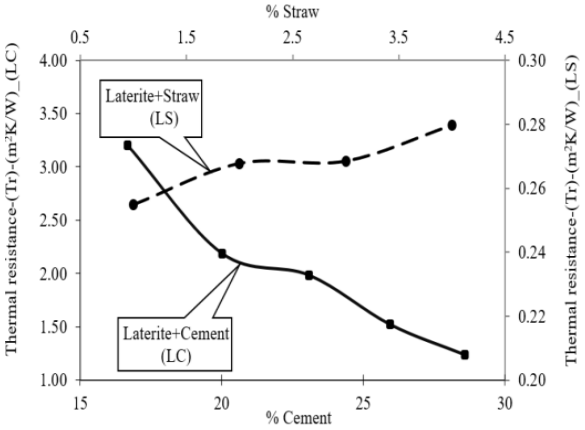


Fig.4. Evolution of thermal resistance according to the percentage of straw mixed with laterite and according to the percentage of cement mixed with laterite, for a wall thickness of 20 cm.

3.4. Thermo-mechanical results

To better see the effects of straw and cement, mixed with laterite, we represent in Fig.5. the evolutions of the thermal and mechanical characteristics.

We can consider that, if wewant to build with the mixture of laterite and cement, we can take the mixture composed of 25.93% of cement. On the other hand, if wewant to build with the mixture of laterite and rice straw, we can take the mixture composed of 3% rice straw.

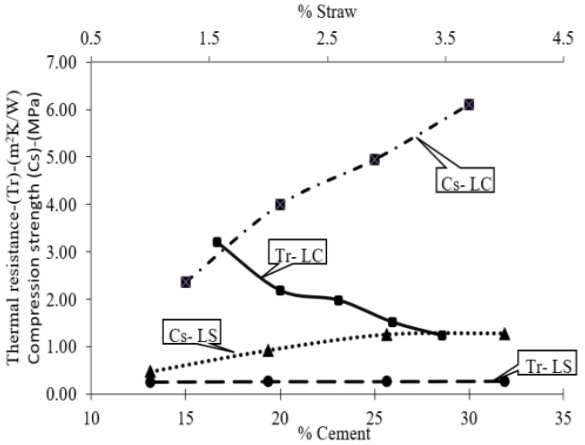


Fig.5. Evolution of compression strength and thermal resistance according to the percentage of straw mixed with laterite and according to the percentage of cement mixed with laterite, for a wall thickness of 20 cm.

CONCLUSION

At the end of our study, we note that mixtures of laterite and cement are better in terms of thermo-mechanical properties. But we see that:

- If we want to build with the mixture of laterite and cement; we can take the mixture composed of 25.93% of cement. This makes it possible to have a compressive strength 5.15 MPa and a thermal resistance 1.52 m^2K/W, considering a wall 20 cm thick;
- Ifwe want to build with the mixture of laterite and rice straw; we can take the mixture composed of 3% of rice straw. This makes it possible to have a compressive strength 1.26 MPa and a thermal resistance 0.27 m^2K/W, considering a wall 20 cm thick.

This work can therefore help us choose between mixtures of laterite and rice straw waste or mixtures of laterite and Portland cement, depending on the compressive strengthand the thermal resistance of social housing designers.

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