

doi: <https://doi.org/10.20546/ijcrar.2026.1405.002>

## Physico-Mechanical Characterization of Laterites from Sindia and Mont Rolland for the Production of Compressed Earth Bricks (CEB)

Mbaye Wade<sup>1\*</sup>, Ndèye Fatou SENE<sup>1</sup>, Macodou Thiam<sup>2</sup>, Makhaly Ba<sup>1</sup> and Mapathé NDIAYE<sup>1</sup>

<sup>1</sup>Laboratoire de Mécanique et Modélisation, UFR SI, University Iba Der Thiam of Thies, Thies, Senegal

<sup>2</sup>Laboratoire de Matériaux, d'énergie, d'électricité et d'économie, University Iba Der Thiam of Thies, Thies, Senegal

\*Corresponding author

### Abstract

Faced with the challenges of sustainable development in sub-Saharan Africa, the use of local resources is emerging as a promising solution for housing. This research examines the feasibility of using laterites from Sindia and Mont Rolland, located in the Thiès region of Senegal, to produce Compressed Earth Bricks (CEBs). To assess their viability, the geotechnical characteristics of these soils were first studied, followed by an examination of the compressive strength of the bricks by varying the amount of cement used (from 0% to 7%). The analyses revealed that these two types of materials, identified as fine clayey sands, exhibit favorable plasticity for CEB production. Compression tests showed a consistent increase in brick strength with increasing cement content and curing time. At 28 days, the results highlighted a slight superiority of the Sindia bricks stabilized at 7% cement, which achieved a strength of 1.107 MPa. In conclusion, although the laterite from Sindia is more reactive to stabilization, both sites offer quality resources for producing durable bricks adapted to the needs of local bioclimatic construction.

### Article Info

Received: 15 March 2026

Accepted: 22 April 2026

Available Online: 20 May 2026

### Keywords

Compressed Earth block, laterite, Cement, Compressive strength.

### Introduction

Today, nearly one in three people on the planet lives in an earthen house (UNCHS/Habitat, 1996). Far from being a relic of the past, this age-old construction method is now fully integrated into sustainable development practices, offering environmental, social, and cultural benefits. This research is part of this dynamic of promoting local materials. Its aim is the production and verification of the characteristics of Compressed Earth Blocks (CEBs) made from laterite. The study precisely analyzes the behavior of these blocks, whether used in their raw state or stabilized with cement, to guarantee their technical reliability. To this end, two sample sites

were chosen: Sindia and Mont Rolland. Tests of total particle size, specific gravity, Atterberg limits, and Proctor Normal were carried out. Compressive strengths at 7, 14, and 28 days were determined from blocks produced using a manual press. After production, the blocks are wrapped in plastic film to prevent water loss.

Compressive strength measurements were taken using the brick crushing method. Physical characterization tests classified these two laterites as clayey sands and low-plasticity sands, with plasticity indices of 13% for Sindia and 12% for Mont Rolland. The results obtained from the 28-day unstabilized compressive strength tests of the bricks were 0.755 MPa for Sindia and 0.551 MPa for

Mont Rolland. At 28 days, stabilization to 7% yielded a compressive strength of 1.107 MPa for Sindia and 0.984 MPa for Mont Rolland. The results show that increasing the cement content leads to an increase in strength for both laterites.

## **Equipment and materials**

### **The manual press**

The bricks used in this study were manufactured using a TERSTARAM manual press (Figure 1). This manual press, thanks to the quality of its products and its robustness, is among the best on the market.

### **He laterites**

He laterites (Figure 2) used come from localities in the Thiès region, Sindia is located in the Mbour department, and Mont Rolland is in the Tivaouane department (Figure 3).

The particle size analysis of the laterites shows that the curves are within the range of soils suitable for use in compressed earth blocks (CEB) according to standard XP P13-901 (Figure 4). A manual sieving system is used to remove excessively large particles that could reduce the strength of the bricks; particles passing through a 5 mm sieve are used for block production. The soil particle size distribution (Table 1) shows that the laterites are not too clayey ( $2 \mu\text{m} < 30\%$ ), which will prevent the risk of shrinkage cracking that could weaken the blocks.

The plasticity indices, which provide information about the clay content of the material, are given in Table 2. They show that the laterites from Sindia and Mont Rolland are moderately plastic (Table 3).

The standard Proctor test for laterites yields an optimal water content of 10.65% for a maximum dry density of 19.70 kN/m<sup>3</sup> for the Sindia laterite and an optimal water content of 9% for a maximum dry density of 18.80 kN/m<sup>3</sup> for the Mont Rolland laterite.

Cement improvement shows that the dry density increases with the percentage of cement added. For a cement improvement of 3% to 7%, the density increases from 19.80 to 20.40 kN/m<sup>3</sup> for Sindia, and from 19.50 to 19.70 kN/m<sup>3</sup> for Mont Rolland (Figure 5). However, an inverse variation is observed for the optimal water content, which decreases with increasing cement percentage (Table 4).

Analysis of the specific gravity determination results shows that the material from the Mont Rolland quarry, with a specific gravity of 26 kN/m<sup>3</sup>, is heavier than that from Sindia, which has a specific gravity of 21.6 kN/m<sup>3</sup>.

## **Formulation of the samples**

Different mixtures of laterite and cement were prepared to assess their influence on the mechanical behavior of compressed earth blocks (CEBs). Blocks 14 cm high, 10 cm wide, and 29 cm long (Figure 6) were produced using different formulations (Sindia or Mont Rolland laterite with 0%, 3%, 4%, 5%, 6%, and 7% cement). For each composition, six samples were prepared. After testing, an average value was determined.

## **Results and Discussion**

### **Compressive strength**

Mechanical characterization tests of compressed earth blocks (CEBs) made from laterites from Sindia and Mont Rolland provided a series of quantitative data on their mechanical properties. The 28-day compressive strength of blocks stabilized with 7% cement and made from Sindia laterite is 1.107 MPa, while that of Mont Rolland blocks is 0.984 MPa. The 7-day compressive strength provides an early indication of block quality and the rate at which they develop their load-bearing capacity. This is important for the initial construction phases, when the blocks need to be moved. The results show that the 7% cement blocks made from Sindia laterite have a 7-day compressive strength of 0.41 MPa, while those from Mont Rolland have a strength of 0.27 MPa (Figure 7). The 14-day compression test allows observation of the strength progression after two weeks of curing. This measurement verifies whether the materials continue to gain significant strength. A substantial increase indicates a good curing process and a continuous improvement in mechanical properties. The results show that the 7% cement, laterite-based blocks from Sindia have a compressive strength of 0.527 MPa at 14 days, while those from Mont Rolland have a strength of 0.544 MPa (Figure 8). The 28-day compression test determines the ultimate strength of the blocks. This strength is generally considered the standard reference for evaluating the load-bearing capacity of construction materials. It is used for structural design and to ensure their safety and durability. The results show that the 7% cement, laterite-based blocks from Sindia have a compressive strength of 1.107 MPa at 28 days, while those from Sindia have a strength of 0.984 MPa (Figure 9).

**Table.1** Soil granularity.

	Gravel	Coarse sand	Fine sand	Silt and clay
<b>Sindia</b>	15 %	53 %	14 %	18 %
<b>Mont Rolland</b>	30 %	38 %	15 %	17 %

**Table.2** laterites plasticity index.

	Plasticity index Ip (%)
<b>Sindia</b>	13
<b>Mont Rolland</b>	12

**Table.3** Material condition according to plasticity index (Philipponnat, Hubert, 2005)

Plasticity index (Ip)	Material condition
$0 < I_p < 5$	Non plastic
$0 \leq I_p < 15$	Moderately plastic
$15 \leq I_p < 40$	Plastic
$I_p \geq 40$	Very plastic

**Table.4** Maximum dry densities and optimum moisture contents as a function of cement content

Cement content	Sindia		Mont Rolland	
<b>0 %</b>	19,70	10,65	18,80	9,00
<b>3 %</b>	19,80	10,60	19,50	10,99
<b>4 %</b>	19,70	10,30	19,90	10,70
<b>5 %</b>	19,40	10,30	20,05	9,20
<b>6 %</b>	20,40	10,00	20,07	9,60
<b>7 %</b>	20,40	10,40	19,70	9,80

**Fig.1** Manual press



Fig.2 Laterites of Sindia (a) and Mont Rolland (b)



Fig.3 Location of the lateritic quarry of Sindia and Mont Rolland.

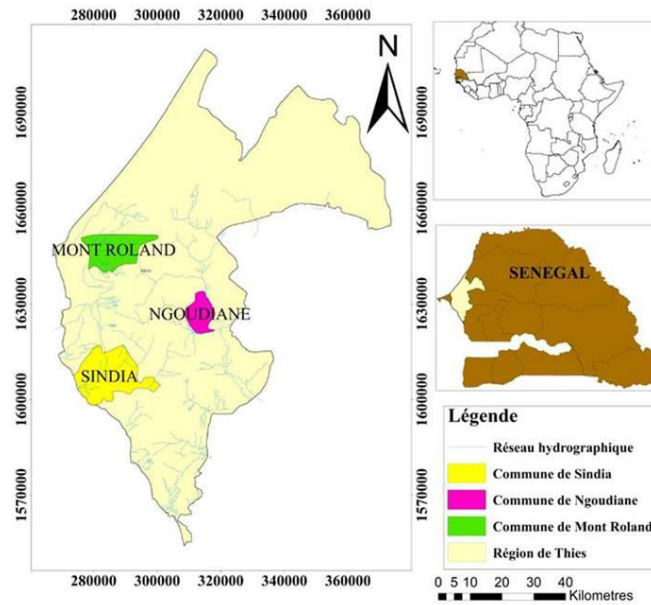


Fig.4 Curve of the granulometric test of laterites in the spindle of good soils for BTC (AFNOR, 2001).

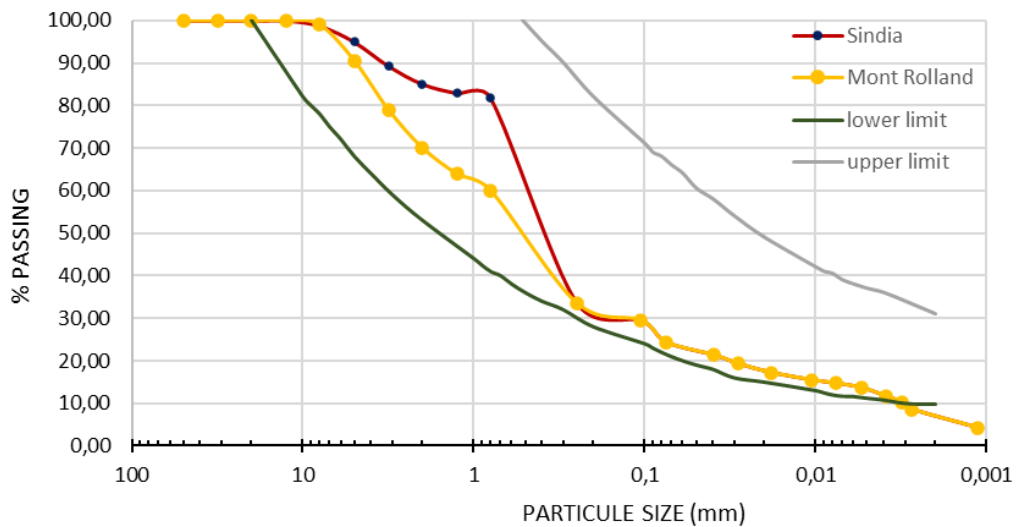


Fig.5 Maximum dry densities as a function of cement content.

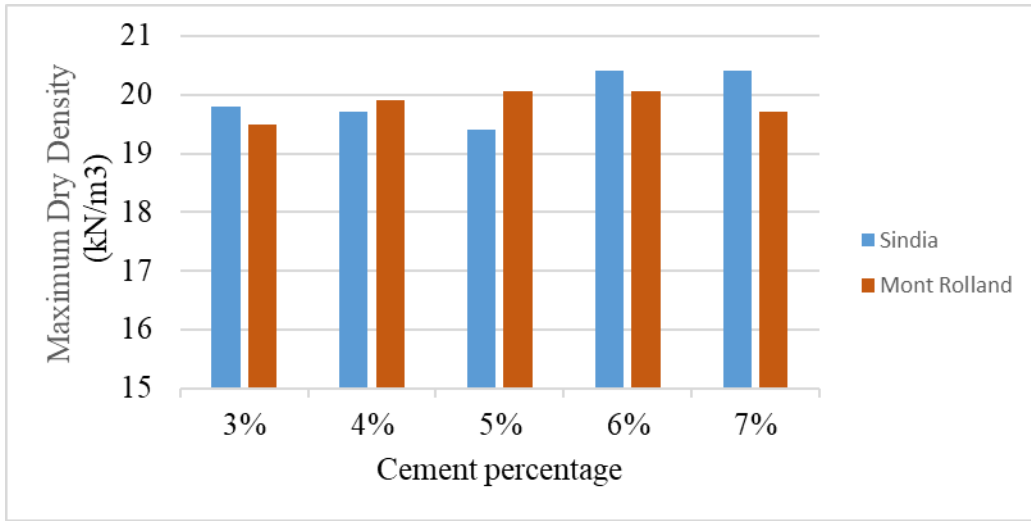
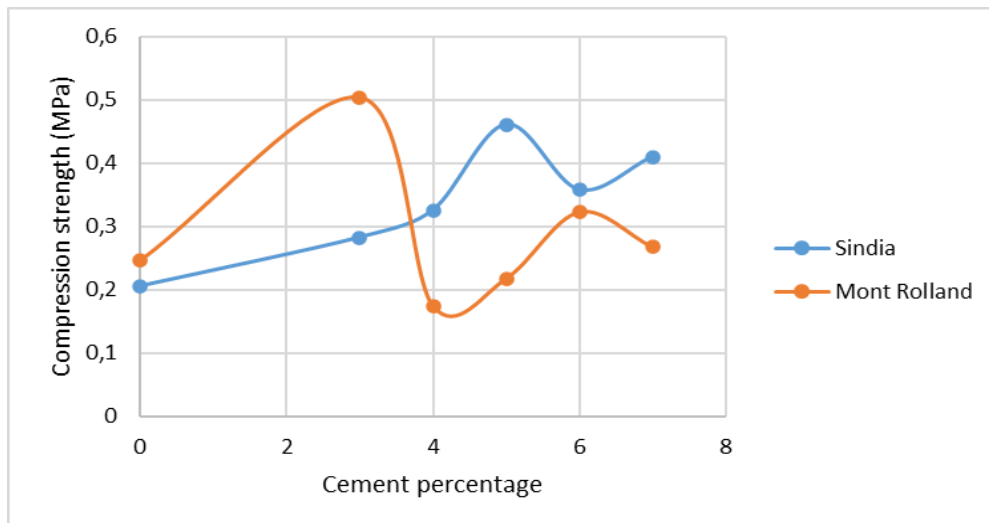


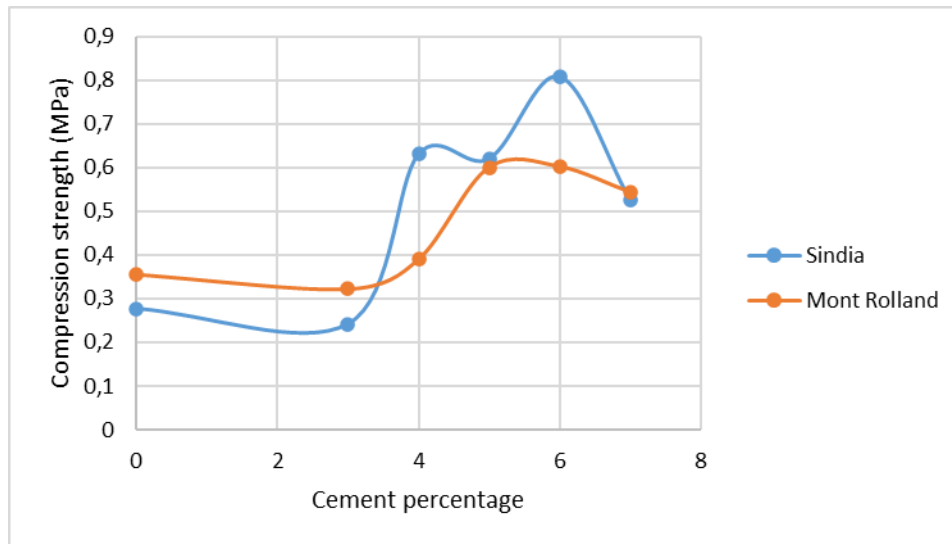
Fig.6 CEB



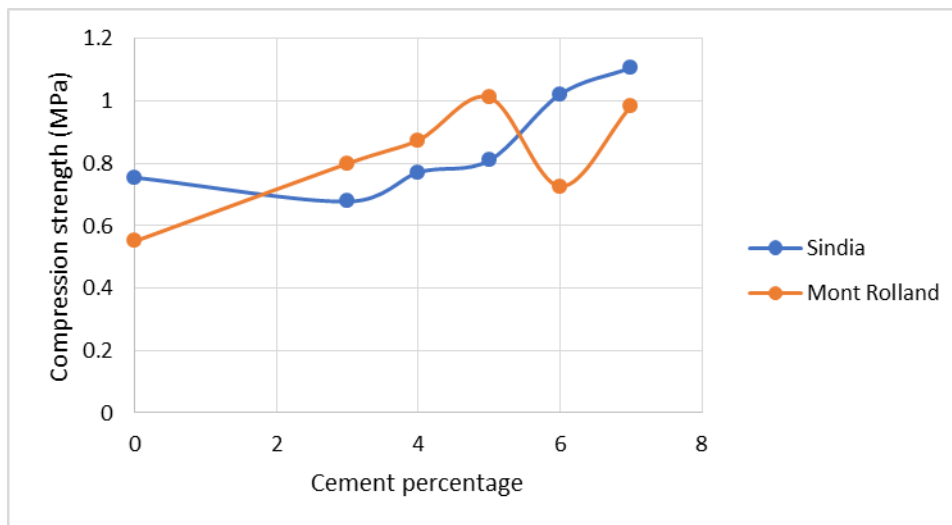
Fig.7 Compressive strength at 7 days as a function of cement percentage.



**Fig.8** Compressive strength at 14 days as a function of cement percentage.



**Fig.9** Compressive strength at 28 days as a function of cement percentage.



In conclusion, these results show that for unstabilized bricks, Mont Rolland offers better compressive strength (0.247 MPa) than Sindia (0.206 MPa), although both are very weak, hence the need for stabilization. For stabilized blocks, Sindia provides the best 28-day strength (1.107 MPa at 7% cement) compared to Mont Rolland (0.984 MPa at 7% cement). The overall compressive strength values obtained remain modest, as Houben and Guillaud, 1994 in (Adam, 2001), recommended at least 2 MPa for cement-stabilized blocks. However, they may be sufficient for a single-story building or one with non-load-bearing walls. The laterite from Sindia produces stronger compressed earth blocks (CEBs), likely due to its slightly higher clay

content and greater density. The role of coarse sand also appears to be more crucial than that of gravel in giving the compressed earth blocks (CEBs) a better granular structure. Furthermore, the laterite from Sindia requires less water and produces more aesthetically pleasing bricks. Looking ahead, thermal and acoustic characterization of the blocks is planned to assess the variation in parameters according to different formulations.

### References

ADAM E. A., AGIB A.R.A. (2001). Compressed Stabilised Earth Block Manufacture in Sudan.

- Paris: Graphoprint for the United Nations Educational, Scientific and Cultural Organization
- AFNOR Association française de normalisation. (2001). XP P13- 901 : Blocs de terre comprimée pour murs et cloisons.
- ORAN: Organisation Régionale Africaine de Normalisation (1998). NOR98: Blocs de terre comprimée. Guides du CDI coédition par CDI et CRATerre-EAG.
- Philipponnat G. et Hubert B. 2005. Fondations et ouvrages en terre. 5e édition, Eyrolles, Paris, 548 p.
- United Nations Centre for Human Settlements (UNCHS/Habitat). (1996). An Urbanizing World: Global Report on Human Settlements 1996. Oxford University Press.

**How to cite this article:**

Mbaye Wade, Ndèye Fatou SENE, Macodou Thiam, Makhaly Ba and Mapathé NDIAYE. 2026. Physico-Mechanical Characterization of Laterites from Sindia and Mont Rolland for the Production of Compressed Earth Bricks (CEB). *Int.J.Curr.Res.Aca.Rev.* 14(5), 15-21. doi: <https://doi.org/10.20546/ijcrar.2026.1405.002>