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Physical, Mechanical and Hygrothermal Properties of Lateritic Building Stones (LBS) from Burkina Faso

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Abstract

Earth is a predominant eco-friendly construction material which provides a good occupational comfort consuming less energy. To improve the durability performance, stabilization is commonly adopted. However the additional costs induced by such process cannot be afforded by the majority of the population in developing countries, and in some circumstances, the environmental side effect may be controversial. Alternatively, laterite stone which is natural available and readily stabilized material that can be used for building construction is studied in this paper. Lateritic building stones (LBS) from Burkina-Faso are studied for their hygroscopic, physical and mechanical characteristics by conducting experimental investigation such as moisture sorption and desorption, moisture buffering, three-point bending, and cyclic unconfined compression test. The analysis is focused on the moisture ingress of the material and its impact on the mechanical strength and also an insight on understanding linear elastic behaviour of LBS is carried out. The experimental results are compared with the stabilized and un-stabilized earthen construction materials. This comparison underlines the good performances of LBS, in both mechanical and hygrothermal properties as a building material.

Keywords: Lateritic building stones, Physical, Mechanical and Hygrothermal Characteristics, Building Materials, Burkina Faso

1 Introduction

With ever growing construction industry, the concern of the environmental aspect is also growing [1, 2]. Because main stream construction materials contribute huge junk to global pollution, the need to promote locally available renewable and sustainable building materials is taking centre stage. Research work on exploring engineering properties of the alternative building material is ongoing. Use of compressed earth block, rammed earth, adobe, etc., are being considered as the strong alternatives [3–8]. Actually, earthen material needs few or no transformation to be used as a construction material and it can be directly extracted close to the construction site. Moreover, the affinity of raw earth for water molecules brings a well-known quality for interior comfort, both acoustic, hygric and thermal [9–12]. The water in the wall is also responsible of its complexity in mechanical behaviour: water retention contributes to the cohesion of the material, but too important water content leads to a strong decrease in mechanical resistance and can lead to collapse [13]. A way to enhance the mechanical performance of earth-based materials, and in particular to limit the impact of water content, is to use mineral stabilizers like lime and cement [14,15]. However, the environmental side-effects of stabilized earth are sometimes controversial [16–18] and the additional costs induced by such process cannot be afforded by the majority of the population in developing countries.

In this context, the use of LBS, which is a sustainable alternative has not been given due importance in terms of its mechanical capabilities. The laterite deposits which are abundantly available in tropical countries [19][20], is rich in aluminium, silica and iron oxides, varies with mineral and chemical composition based on formation [21]. The mineralogy and natural chemical stabilization due to weathering makes this porous material sufficiently strong, thus it is cut and used as building blocks. The term laterite was first coined by Buchanan in 1807 [20], then it was used as replacement for bricks in Malabar region, India.

Thanks to its natural inherent property, making way to be potential alternative building material. Due to lack of sufficient scientific data, confidence level in using it as an alternative building material is decreasing [22]. Variation in mineral and chemical composition due to different exposure makes it even more important to have scientific knowledge about the material property to propose a standardized procedure.

Mechanical parameters such as compressive strength, flexural strength were studied by the active researchers in India and Africa. From studies [23–26], variation of strength with location and strata were observed, and also variation of strength in dry and saturated condition was reported. Due to climate condition in tropical countries, and laterite being porous medium, material response to moisture buffering condition and its influence on mechanical parameters need to be given due importance. These parameters being vital in promoting laterite stonesas a sustainable alternative, and lack of scientific data promoted this study. In this paper, the LBS from Burkina-Faso is tested and analysed for its response to moisture buffering by studying sorption and desorption, dynamic moisture buffering, and mechanical characteristics such as flexural strength, compressive strength and modulus of elasticity.

2 Materials and methods

2.1 Description of the tested material

The quarry of studied LBS is situated in Toussiana, located at 10°50’ N, 4°37’W in the province of Houet, West of Burkina Faso, geographical map is show in Figure 1. Use of locally available LBS proves economical due to its low cost benefit and better thermal comfort, in surrounding locality the LBS are mainly used for building houses, churches, schools, etc. Lateritic stone blocks of dimension 240×120×120mm transported from the quarry are tested for its properties, the dry density of the material was found to be 1.85g/cm^3 with 23% porosity and the thermal conductivity at 23°C and 50% RH was found to be 0.96W/(m.K) from ‘FP2C’ hot wire apparatus manufactured by NEOTIM. The density of the other alternative building materials such as CEB, unstabilised rammed earth and adobe, reported from earlier studies are in between 1.5-2.2g/cm^3 [27,28], 1.8-2.2g/cm^3 [29–32] and 1.3-2.2 g/cm^3 [8,33–35] respectively depending on the water content and compaction energy adopted while manufacturing. Considering similar material properties and local availability; use of lateritic stone as an alternative looks to be more beneficial, economical and eco-friendly.

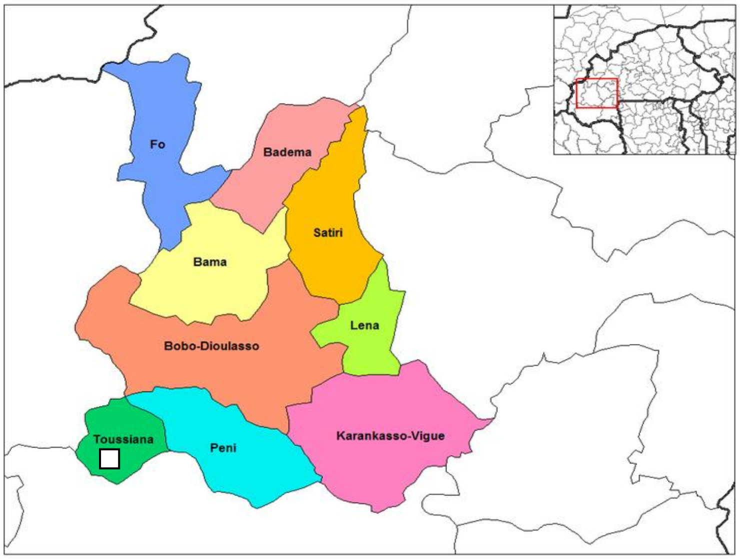

Figure 1: Location of Toussiana in the province of Houet in Burkina- Faso

2.2 Procedure and sample conditioning for the hydric tests

2.2.1 Sorption isotherms

The sorption isotherms were measured to describe the hygroscopic behaviour of the material. The sorption isotherms indicate the moisture content adsorbed by the material to reach equilibrium with the vapour pressure of the surrounding environment. Sorption and desorption isotherms were measured according to the ISO standard [36]. Airtight containers were used with saturated salt solutions to set imposed relative humidity (RH) levels. All samples were previously oven dried at 105°C to constant mass before placing them successively in RH levels of 23, 43, 59, 75, 85 and 97%. The airtight containers were placed in a conditioning room at 20°C and 60% RH. Scales with a precision of 0.01 g were used to record the mass variation of the samples. The mass was recorded until the variation was less than 0.02 g between two measurements. Before starting the desorption curve the samples were humidified at 97% RH until stabilization and then placed in different RH levels. A repetition of three samples per RH was realized to minimize measurement errors.

2.2.2 Dynamic vapour sorption-desorption test

The moisture buffering test was used to investigate the dynamics of moisture adsorption when the material is exposed to a change in vapour pressure from the surrounding environment. With a high buffering capacity, the material may have a positive influence to stabilize fluctuations in the internal environment of dwellings. Such behaviour is commonly allocated to hygroscopic porous building materials such as raw earth and also bio-based materials. The moisture buffering test consists of exposing a known surface of the sample to fluctuating RH levels under isothermal conditions. Small samples of 120 mm x 60 mm with a thickness of 60mm were sealed on all surfaces a part one which was the exposed surface. The procedure of the Nordtest was followed [37], the samples were exposed during 8h to a RH of 75% then during 16h to RH of 33% at 23°C. The moisture buffering value (MBV) practical (1) could be calculated from stable cycles.

$$MBV_{practical} = \frac{\Delta m}{A.\Delta RH} \qquad \text{Equation1.}$$

Stable cycles occur when the variation between the initial mass and the final mass of the cycle is less than 5%. Depending on the material stable cycles are achieved more or less rapidly. In this case the stabilization occurred rapidly after 4 to 5 cycles. The samples were initially preconditioned at 50 %RH and 23 °C.

2.3 Procedure and experimental protocols of the mechanical tests

2.3.1 Sample conditioning

Lateritic stones are cut into seven small beams of dimension 240mm×60mm×60mm (L×b×d). Two of these beams designated as N1 and N2 were stored at 25°C and 50% relative humidity in a climate controlled chamber until the moisture equilibrium is attained, the average moisture content during testing was found to be around 2%. Two other beams designated as D1 and D2 were stored at 100-105°C for obtaining oven dry state. The remaining two designated as W1 & W2 were moisten by spraying known quantity of water and wrapped air tight before storing in the climatic chamber at 25°C, the moisture content during test was found to be around 4%.

From the specimens tested for the flexural strength, largest rectangular shaped part is recovered and dressed to fulfil the aspect ratio; such that dimension of the test specimen is 120mm×60mm×60mm (h×l×b). Samples tested for compressive strength are stored and conditioned in similar conditions as described for flexural beam specimens.

2.3.2 Three point bending test

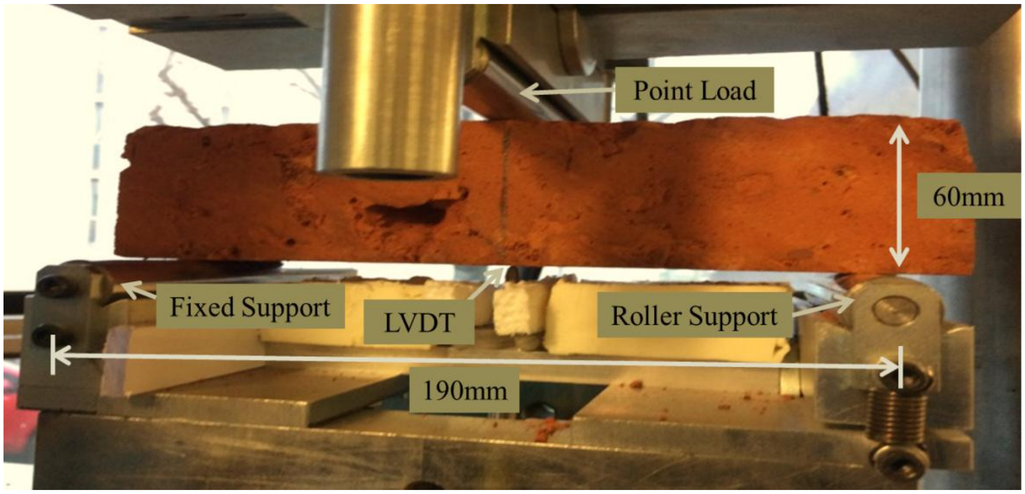

Figure 2 : Three Point Bending Test set up

Customized three point loading system is positioned on the uniaxial compressive testing frame. The base frame of the three point loading system has two adjustable supports (roller support at one end and hinge at the other end). Lateritic specimen of length 240mm is positioned on the supports with span of 190mm. Figure 2 shows the three point bending test setup for lateritic beam specimens. Beam displacement is measured using LVDT, which is placed below the point load where the maximum deflection occurs due to bending. Specimens in bending test are programmed to load at 5μm/s displacement controlled rate. Due to limited quantity of Lateritic stone blocks, flexural test are planned for three moisture content. Lime paste was used to prepare an even and smooth surface at LVDT point of contact.

2.3.3 Unconfined Compressive Test

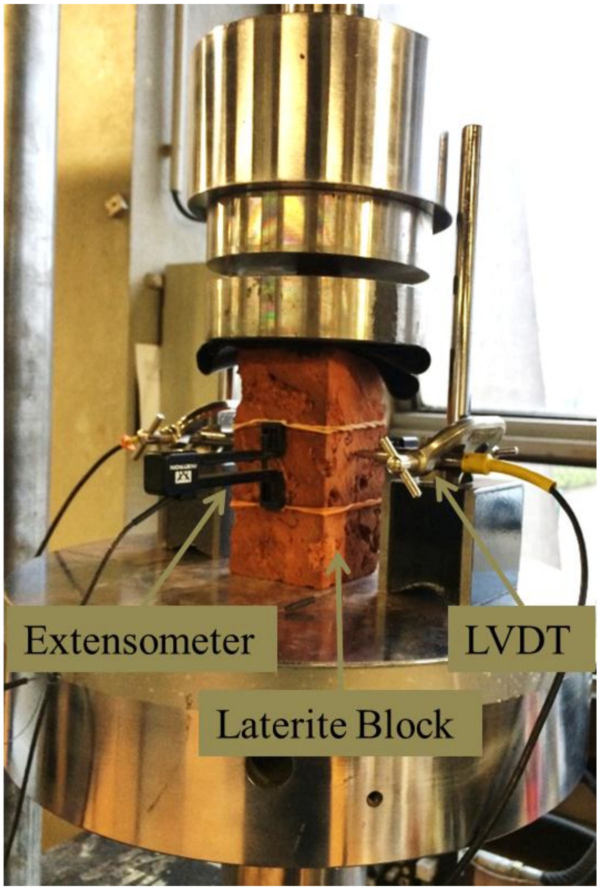

Figure 3 Compression Test Setup

In this study, it was decided to carry out unconfined compression test on the LBS because it gives the most accurate strength of the material [28,38,39]. In this test, axial and lateral displacements of the specimen are measured using extensometer and LVDT respectively. As shown in Figure 3**Error! Reference source not found.**, two extensometers of 22.5mm length are mounted on the opposite face of the specimen, to avoid the platen effect extensometers are positioned on the mid 1/3rd height. On the other two opposite faces, LVDT's are positioned at mid-height to measure lateral displacement. Due to uneven surface, measurements of the LVDT's are not precise and are neglected in this analysis.

To study the elastic behaviour of the lateritic stone, specimens are subjected to cyclic loading at 5 pre-defined loads. The 5 pre-defined loads are 0.36kN, 1.08kN, 1.62kN, 2.72kN and 3.78kN. For each pre-defined load, three repetitions were followed before moving to the next pre-defined load. Test was programmed such that, after reaching the defined load, specimen was unloaded until 0.36kN in each repetition, except for the first cycle in which specimen was unloaded to 0kN. At the end of fifth cycle for 3.78kN load, specimen was loaded until failure. All specimens were loaded throughout the test at a controlled displacement rate of 5µm/s.

3 Hydric characterization

3.1 Sorption-desorption isotherms

The experimental results of the measured mass variation are shown in Figure 4 as the moisture equilibrium points for the adsorption and the desorption curve. The difference between adsorption and desorption curves is the hysteresis loop. The International Union of Pure and Applied Chemistry (IUPAC) describe four types of hysteresis loops H1, H2, H3 and H4. The hysteresis loop observed for the lateritic stones is of H3 type. In Rouquerol et al. [40] the H3 type hysteresis loop is described as resulting from aggregates of platy particles or adsorbents containing slit-shaped pores.

The error bars represented in Figure 4 represents the variation within at least 3 samples measured per RH. It is common to have greater uncertainty at higher humidity levels as seen in this case.

In Figure 4, the sorption isotherm of the Lateritic samples is compared with a soil used as unstabilised rammed earth (St Antoine) and a Stabilized Rammed Earth (SRE). The data for the SRE sample was taken from Hall and Allinson [41], the desorption data was ignored as only a very small hysteresis could be observed. The 433 mix corresponds to a SRE mix containing 4 volumes of gravels, 3 volumes of sand and 3 volumes of silty clay. The sorption isotherms of the lateritic material show strong adsorption capacity compared with the rammed earth materials, see Figure 4.

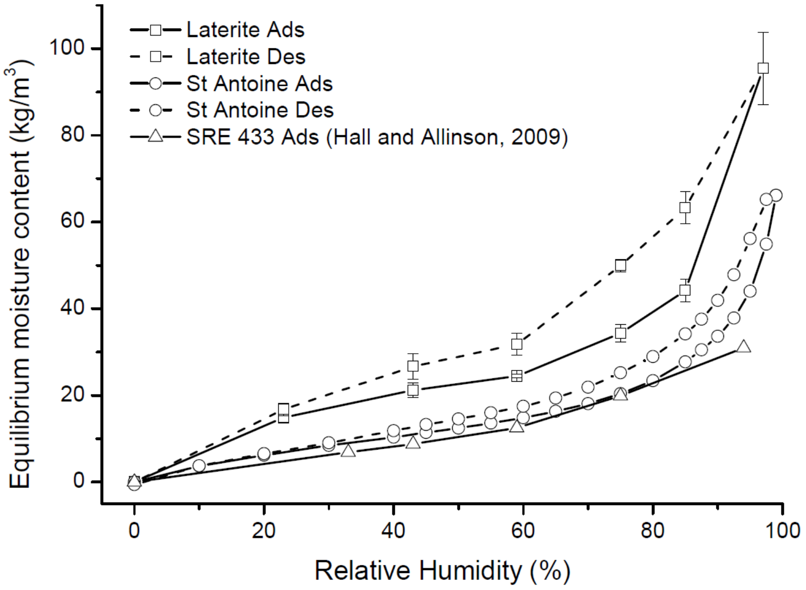

Figure 4 : Adsorption (Ads) and Desorption (Des) isotherms (SRE: Stabilized Rammed Earth, 433 samples from Hall and Allinson, 2009 [41]**)**

3.2 Moisture Buffering Value Test

Figure 5, shows the results of the moisture buffering test. Data points are the average of the results of three samples. The error bar is a simple representation of the standard deviation within the results of the three samples. The results are compared with unstabilised earth (St Antoine) used for a rammed earth building and the SRE sample from Allinson et Hall [42]. The lateritic sample has a very high adsorption compared to the earth samples.

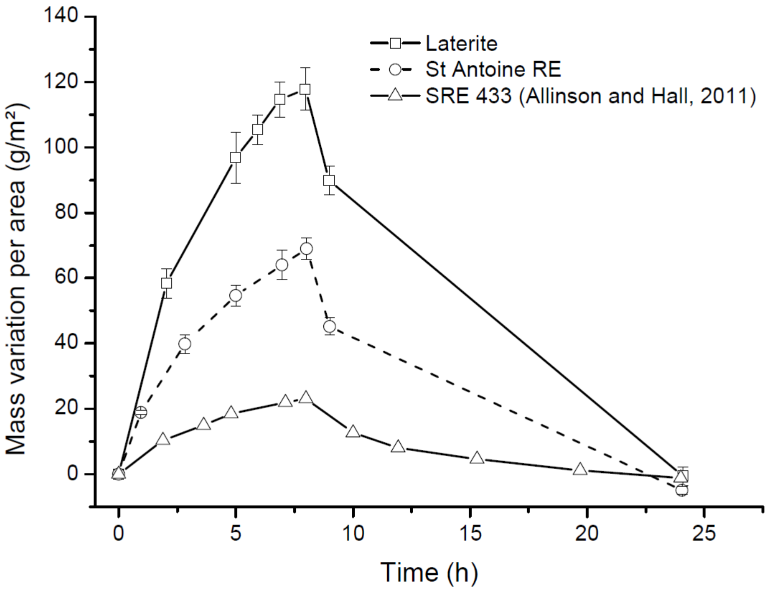

Figure 5: Moisture buffering test

From the experimental curve the $MBV_{practical}$ can be calculated according to equation 1. From the data of the three samples the maximum value after 8h of adsorption varies between 111 and 124 g/m^2. Therefore the MBV varies between 2.65 and 2.95 $g/(m^2.\%RH)$. In the classification proposed in [37] the lateritic building stones would therefore classify as excellent buffering materials.

4 Mechanical characterization

4.1 Three point bending test

As briefed earlier, in the flexural testing, beam deflection is measured by the LVDT positioned right below the load point. Point load is measured in Newton [N], and the deflection is measured in mm. From theory of bending, the equations to calculate flexural stress in MPa and Strain are given below.

$$\sigma_{xx} = \frac{3\,P\,L}{2\,b\,d^2} \qquad \text{Equation 2.}$$

$$\varepsilon_{xx} = \frac{6\,d\,\delta}{L^2} \qquad \text{Equation 3.}$$

With σ_{xx} : the flexural stress or modulus of rupture in [MPa], P : point load in [N], L : length of the beam span (in mm), b : breadth of the beam (in mm), d: depth of the beam (in mm), ε_{xx} : longitudinal strain (in mm/mm), δ : deflection of the beam under point load (in mm).

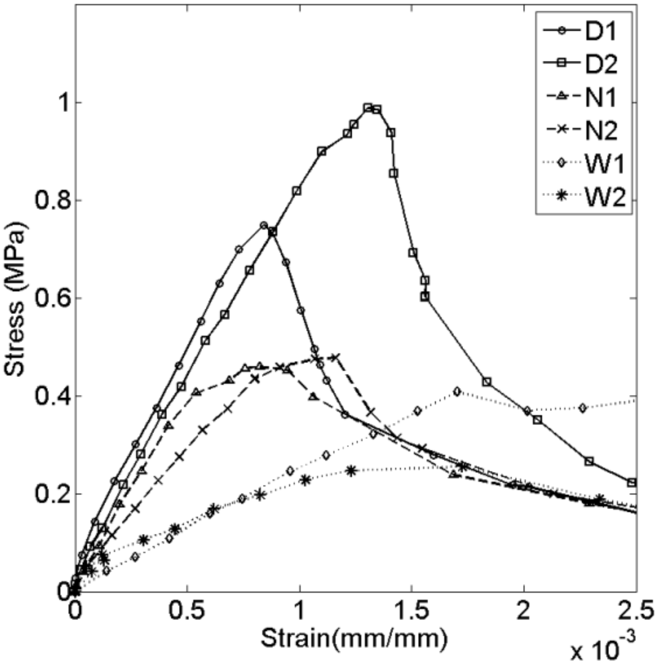

Figure 6: Flexural stress- strain of lateritic specimens

From the load and deflection data obtained during the test, the flexural stress-strain characteristics of the lateritic stone beams in 3 points bending test is plotted as shown in Figure 6. 'N' representing series exposed to ambient atmosphere with internal moisture of 2%, 'D' representing series with dry state specimens and 'W' representing specimen with average moisture content of 4% during the test. As predictable, specimen with low moisture content exhibits higher flexural strength characteristics. The average flexural strength of the lateritic specimens at ambient condition is found to be 0.49MPa. There is a tendency of decrease in flexural strength of the material with increase in moisture content as shown in Figure 7. The average flexural strength of the lateritic specimen at 4% moisture content is 40% of the dry state flexural strength. The average flexural modulus of the laterite in ambient condition is calculated to be 650MPa; the flexural modulus of the material is calculated by plotting the best fit linear secant tangent up to rupture of the material. Results of flexural properties of laterite stone beam are presented in Table 1.

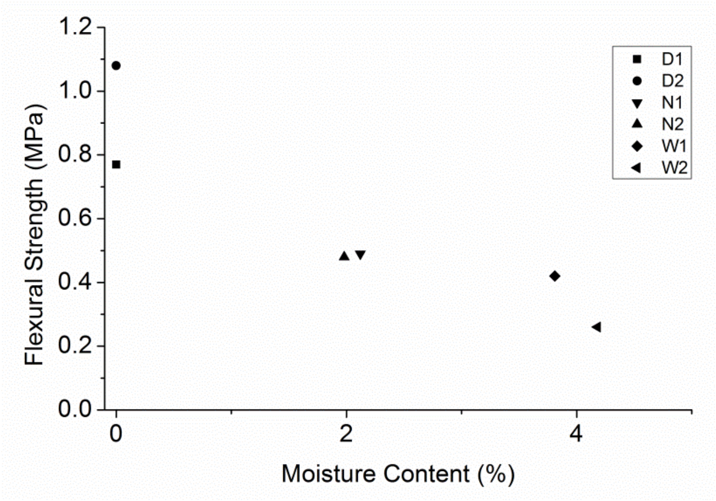

Figure 7 : Variation of Flexural Strength with change in Moisture at test

Table 1 - Flexural Property of Laterite Stone Beam

Flexural test	Storage	Water Content [%]	Loading rate [µm/s]	Max Load [N]	Max Deflection, mm	Flexural Strength, MPa	Flexural Modulus, MPa
D1	100°C	0	5µm/s	573.5	0.084	0.77	880
D2		0		750	0.13	1.08	780
average	-	-	-	-	-	0.93	830
N1	25°C, 50% RH	2.1%	5µm/s	333	0.089	0.49	800
N2		2.0%		362	0.096	0.48	510
average	-	2.0%	-	-	-	0.49	650
W1	25°C	3.8%	5µm/s	310	0.17	0.47	230
W2		4.2%		189	0.13	0.26	190
average	-	4.0%	-	-	-	0.37	210

4.2 Compressive Strength

The compressive stress strain characteristics of the laterite specimen tested in unconfined compression test are shown in Figure 8. The compression test was carried out on 6 specimens, 2 specimens each in ‘N’, ‘D’ & ‘W’ series. The average compressive strength of the laterite stone specimen exposed to ambient environment is found to be 2.4MPa, a detailed summary of compressive test results are given in Table **2**. Similar to earthen construction materials, compressive strength of the laterite stone decreases with increase in moisture content as shown in Figure 9. The average compressive strength of the laterite stone specimen with 4% moisture content is found to be 55% of its dry compressive strength.

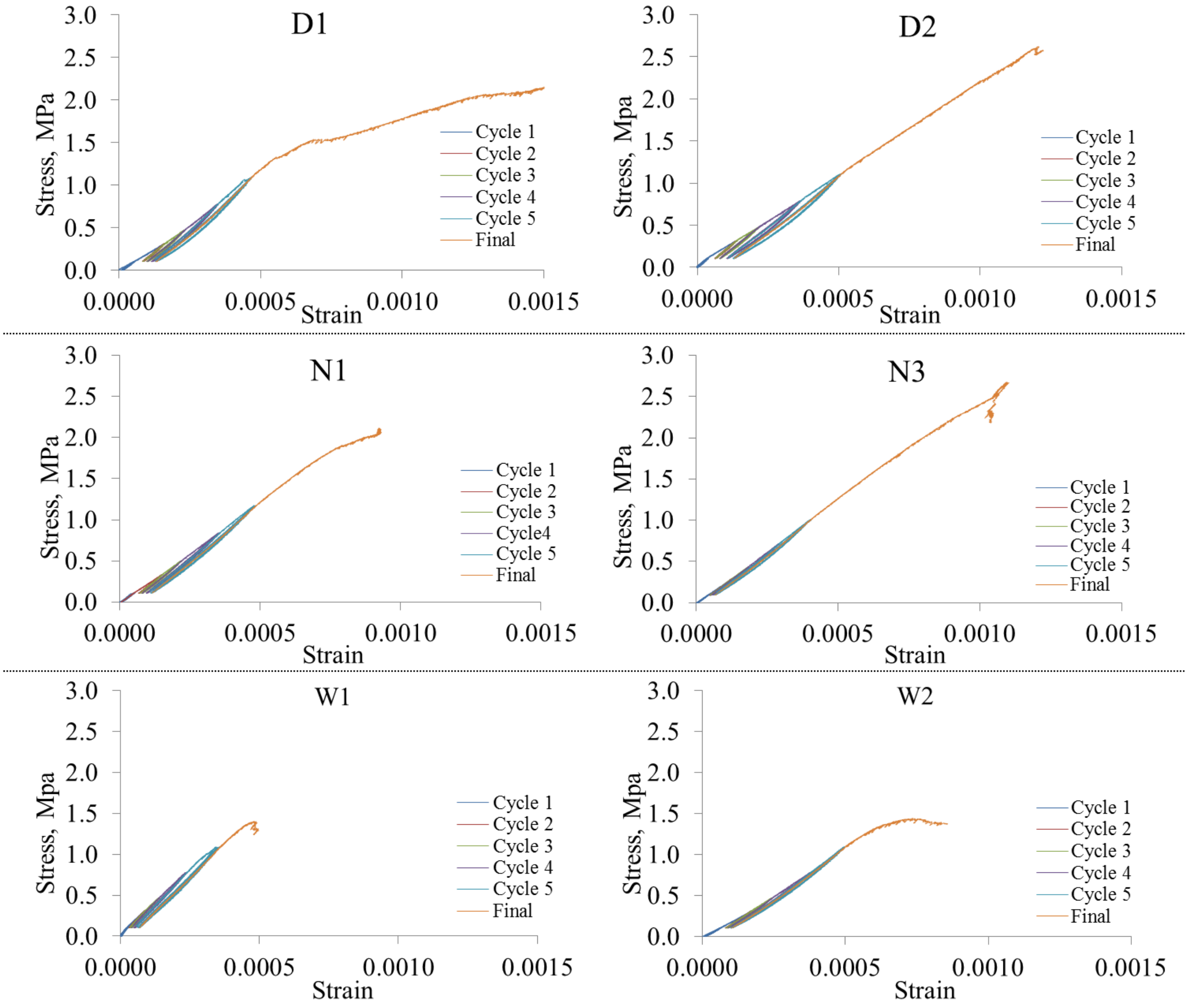

Figure 8- Stress-Strain Graph of Compression Test

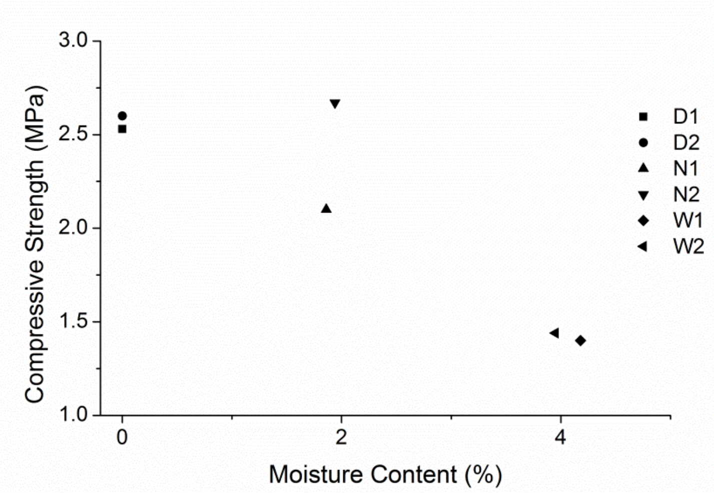

Figure 9: Variation of Compressive Strength with Moisture

Table 2- Results of Compression Test

Compression Test	Storage	Water Content	Compressive Strength, MPa	Secant Modulus (Peak), MPa
D1	100°C	0	2.5	2220
D2			2.6	2150
average	-	0	2.6	2190
N1	25°C & 50% RH	1.9%	2.1	2460
N2		1.9%	2.7	2490
average	-	1.9%	2.4	2470
W1	25°C	4.2%	1.4	2970
W2		4.0%	1.4	2160
average	-	4.1%	1.4	2560

4.3 Young's modulus

Cyclic loading is very helpful in understanding the elastic behaviour of the material, in this analysis to calculate the elastic modulus (secant), best fit linear line is drawn to each cycles (including 3 repetitions) as shown in Figure 10, where all the cycles are shown. The secant modulus of the first cycle is called as the initial secant modulus, which is low compared to cycles (2-5), this may be attributed to the closer of micro cracks in the material. Figure 11 shows the secant modulus of samples at various stages during loading. The variation of the secant modulus between cycles 2-5 is less and exhibits linearity. The average cyclic (2-5) secant modulus was found to be 2700MPa for both dry and ambient condition. In Figure 12, initial secant modulus, average of secant modulus of cycles 2, 3, 4 and 5 and secant modulus at peak are plotted against the variation of moisture. The behaviour of moist samples doesn't provide convincing information. The variation between initial secant modulus and secant modulus at peak is seen to be negligible (less than 10%) at dry and ambient condition; this may suggest secant modulus at peak can be considered for analysis. It should also be noted that the secant modulus at dry and ambient condition doesn’t vary much, so the assumption of linear behaviour seems to be correct for this kind of material, if water content remains limited.

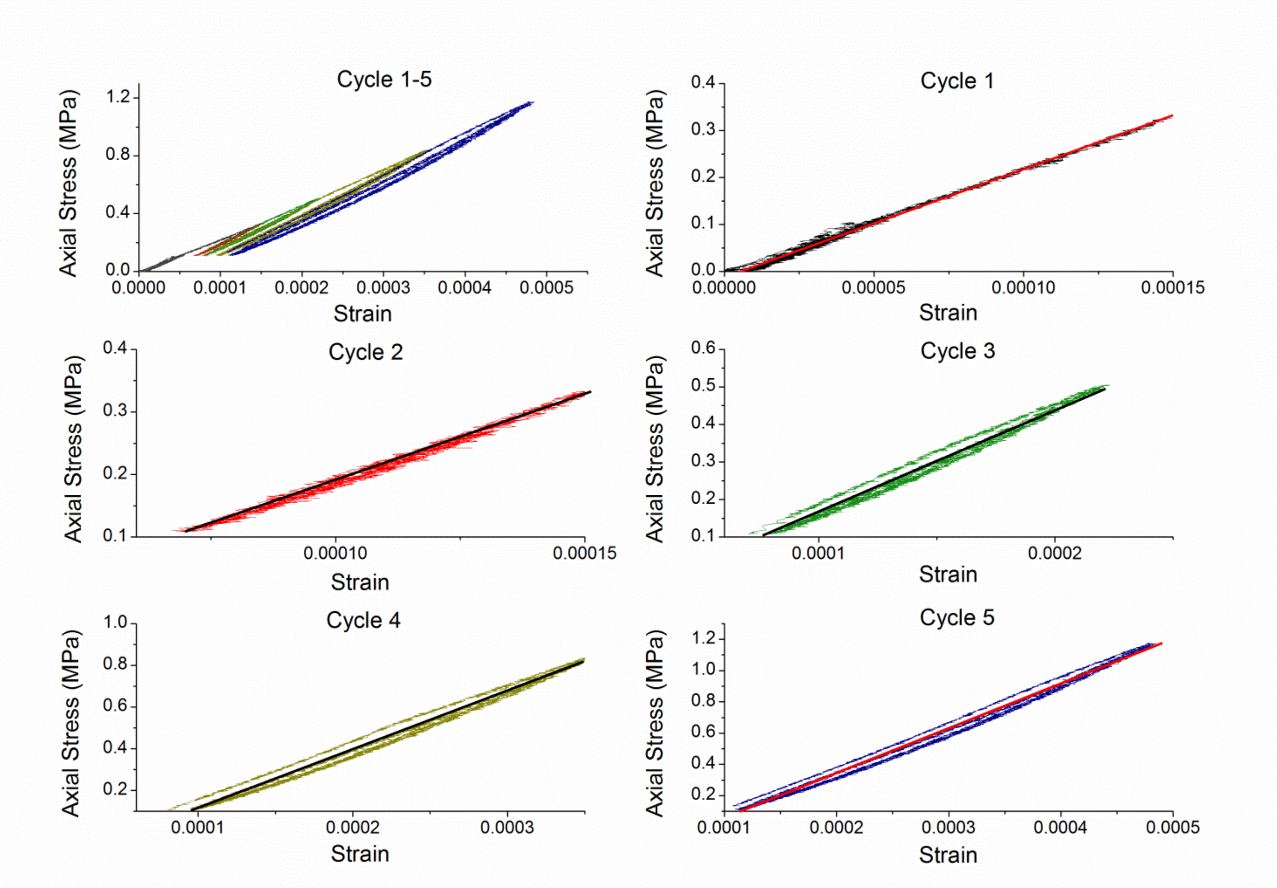

Figure 10 : An Example of Elastic behaviour of Laterite Stone Specimen

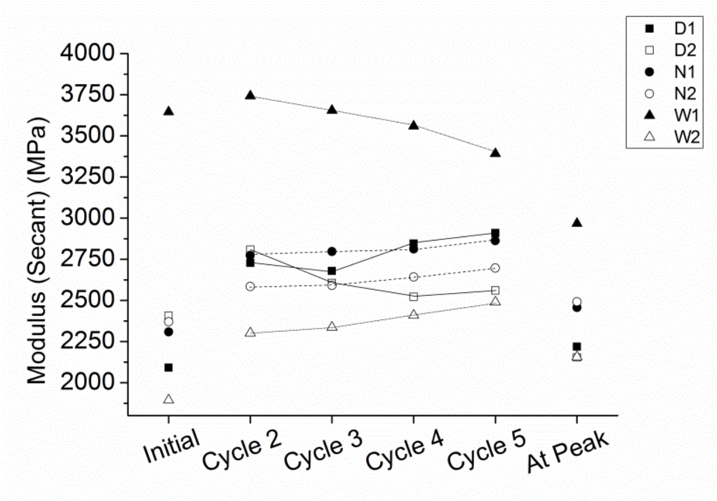

Figure 11: Variation of Modulus at each cycle

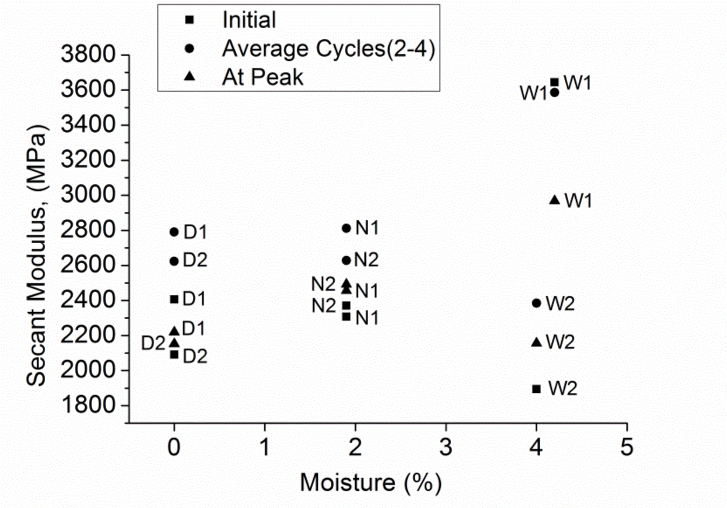

Figure 12: Change of secant modulus and average cyclic modulus with change in moisture

4.4 Irreversible strain

From cyclic loading it was observed that the material exhibits residual strain after reaching 1.08kN load (cycle2). In the first cycle, material completely regains its straining showing perfect elasticity. From second cycle, when material is loaded to 1.08kN and above, material does not regain its original shape upon unloading. For calculating elastic strain (ε_e) recovery and plastic strain (ε_p), the last known strain upon unloading of each cycle is linearly extended on to the x-axis as shown in Figure 13, the point of intersection on the x-axis is the plastic strain material has undergone for that cycle. The maximum strain material has undergone for each cycle at its maximum stress is taken as ε_t. The ratio of plastic strain (ε_p) to total strain (ε_t) of each cycle is taken as the percentage of plasticity material has undergone for a cycle, the plastic property of laterite tested specimens are shown in Figure 14. Specimens D1 & W2 has wide spread plasticity, it was observed these specimens has prolonged straining before failure, whereas the other specimen showed brittle failure nature. Though it is difficult to quantify the plasticity of the material, in general it can be said that material shows less than 25% plasticity, this information adds value to the assumption of linear behaviour. The maximum stress and strain values of the laterite test specimens are given in Table 3.

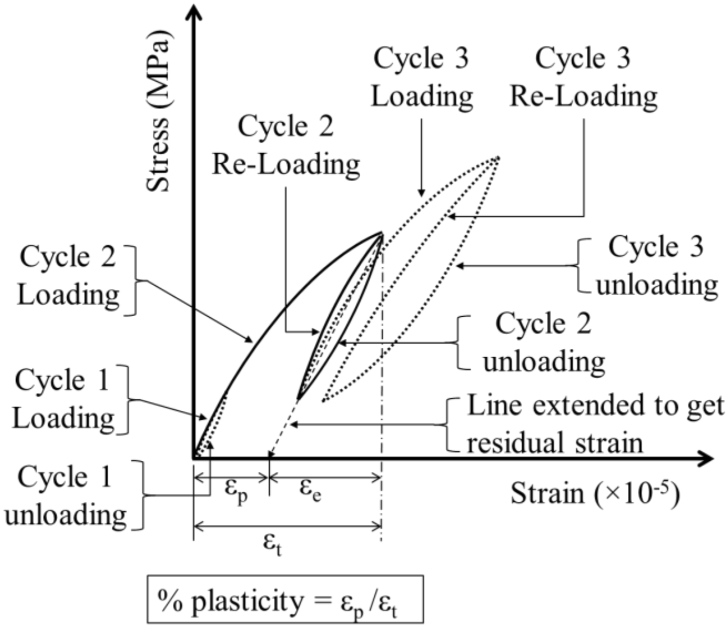

Figure 13: Graphical explanation for calculation of plasticity

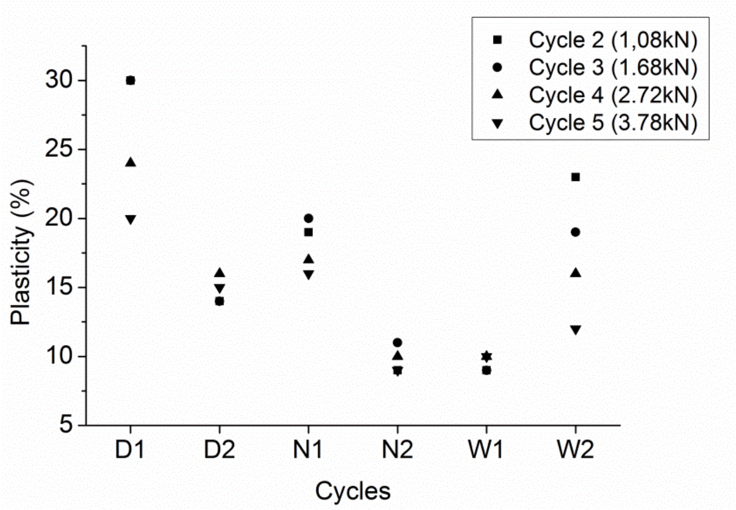

Figure 14: Percentage of plasticity undergone by specimens with respect to cycles (load)

Table 3: Failure Stress - Strain

Laterite Specimen	Moisture [%]	stress at failure σ(max), MPa	Strain at failure ε, [10^-5]
D1	0	2.5	160
D2	0	2.6	120
N1	1.9	2.1	90
N2	1.9	2.7	110
W1	4.2	1.4	50
W2	4.0	1.4	90

5 Discussion

The first remarks can be made on the highly hygroscopic characteristics of the material. Sorption isotherms exhibit a strong hysteresis and between 20 to 40 kg/m^3 water content in the middle range of relative humidities. In this study the laterite samples compared with rammed earth samples present higher hygroscopic water adsorption characteristics. The moisture buffering results show the same trend with a dynamic adsorption at least twice the values of the rammed earth samples and comparable to those obtained for unfired clay bricks [43].

The corresponding calculated MBV is 2.8 g/m².%RH for 75%/33% RH cycles. MBVs over 2 g/m².%RH are considered as excellent moisture buffering materials. From these results it can be concluded that the material can have a positive impact on indoor air quality. Any exposed surface will act as a passive climate regulator. This potential has previously been described for other building materials [44]. It can however be discussed if such behaviour would also be effective in tropical climates where Laterite stones can usually be found. A study using simulation tools to access the influence of the building envelope on the interior climate in tropical climate conditions shows that the addition of hygroscopic materials lowers the interior RH peaks [45].

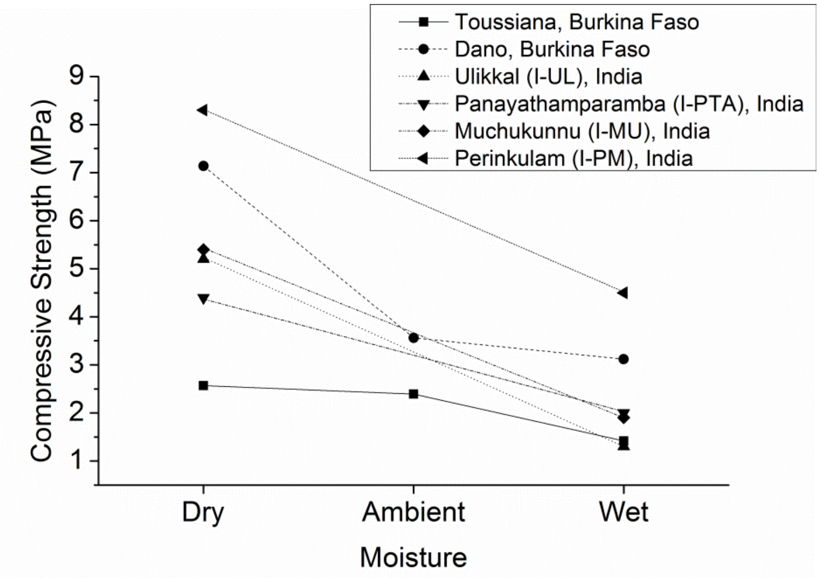

Figure 15: Variation of compressive strength of Laterite (different quarries) with moisture

Compressive strength of porous material varies with change in moisture condition. Experimental results show that, the compressive strength of LBS reduces with increase in the moisture content. In Figure 15, the compressive strength at different moisture state of laterite blocks from Dano, Burkina Faso [24] and Malabar region, India [22] are presented along with the LBS (Toussiana) experimental results obtained from this study. Ulikkal (I-UL), Panayathamparamba (I-PTA), Muchukunnu (I-MU) and Perinkulam (I-PM) are different quarries of laterite blocks in Malabar region, India [22,26]. Wet compressive strength of laterite blocks from Malabar region in between 25%-54% of its dry compressive strength, the variation in compressive strength depends on the quarry and composition of rock [46]. The dry, ambient and saturated compressive strength of laterite blocks from Dano, Burkina Faso [24] are shown in Figure 15, it has to be noted that, the aspect ratio [28] of the test specimens in this case were less than 2, hence compressive strength of laterite blocks from Dano, Burkina Faso might require coefficient of correction. The ambient compressive strength of laterite block (Dano) is 50% of its dry state, whereas the tested material from Toussiana losses only 7% of its dry compressive strength at ambient condition. In both cases, moisture at ambient condition is around 2%. Wet compressive strength of laterite blocks (Dano) is 45% of its dry compressive strength. In general, it can be said that the wet or saturated compressive strength of laterite stones is 40%-50% of its dry compressive strength.

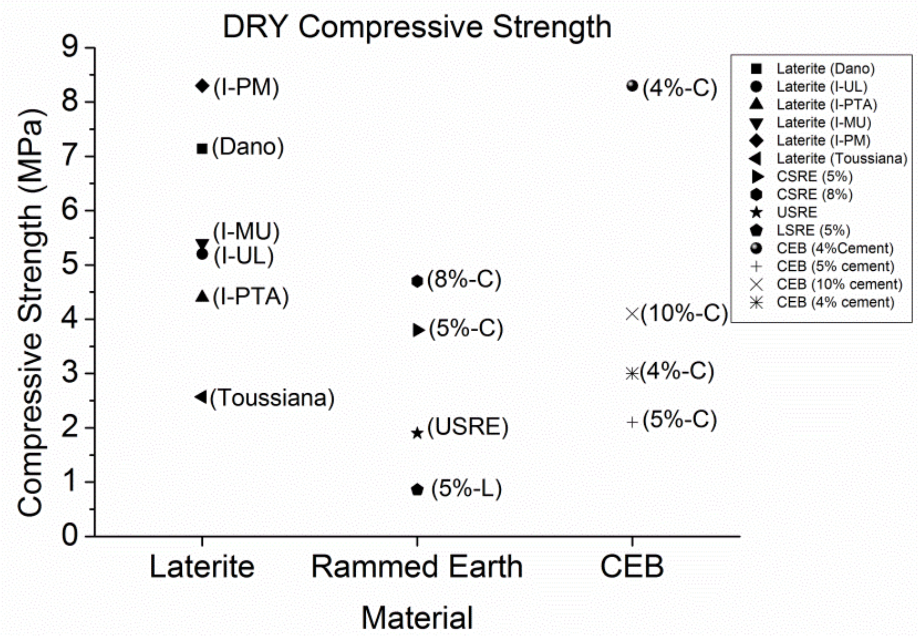

Figure 16: Comparison of compressive strength of Laterite, Rammed earth, CEB at dry state.

Compressive strength of a building material is one of the decisive factors in recommending its suitability as an alternative construction material. In this analysis for comparison, stabilised compressed earth block (CEB) [7,28,47,48], cement stabilised rammed earth (CSRE) [49], lime stabilised rammed earth (LSRE)[15], and unstabilised rammed earth (USRE) [29] are considered. The dry and wet compressive strength of the materials are considered and plotted as shown in Figure 16 & Figure 17. The dry compressive strength of the rammed earth varies between 1-5MPa, the compressive strength of the USRE being the lowest, with increase in the percentage of cement and lime content there is increase in strength. Similarly compressive strength of stabilized CEB varies between 2-8MPa, depending upon the percentage of cement and clay in the soil[47]. In the case of laterite, dry compressive strength varies from 2.5-8.3MPa depending on the quarry and its chemical and mineral composition, the material tested in this study exhibits 2.6MPa as the average dry compressive strength.

In general wet compressive strength of stabilised rammed earth and stabilised CEB losses 50% of its dry compressive strength, similar to the case of LBS. As shown in Figure 17, wet compressive strength of rammed earth is in between of 0.5-2.3MPa, and that of CEB is in between 1.2-3.2MPa. It is interesting to see that the wet compressive strength of laterite also varies in the range of 1.4-3.2MPa, the material tested in this study has an average wet compressive strength of 1.4MPa.

This shows that the dry & wet compressive strength of LBS is similar to stabilized earth materials. According to [19] the induration process of laterite soils involves the crystallisation of iron oxide minerals cementing the aggregates over a more or less long period of time. A further physico-chemical study of the nature of this induration may allow its comparison and potentially replicate the process to the stabilisation of earth materials. Compared to the stabilisation of earth materials the natural induration of laterite soils has no environmental impact yet the use of laterite stones involves extraction and transport from the quarry to the building site and therefore increasing its environmental impact compared to unfired earth. It is interesting to note that the mechanical characteristic of laterite varies with quarry, region, and nature of deposits. The variation of strength with quarries might be attributed to change in the chemical and mineral composition during induration process, to understand how laterite stone gains its strength, a detail mineral and chemical analysis has to be carried out.

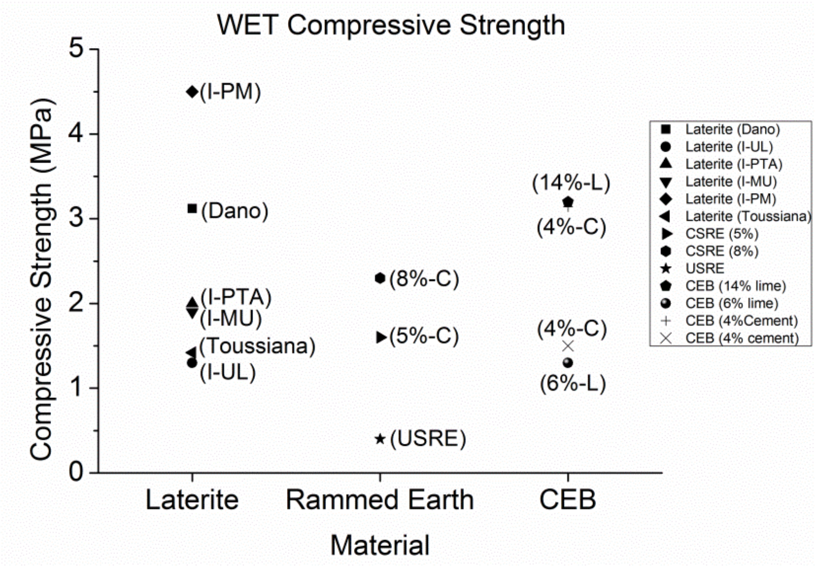

Figure 17: Comparison of compressive strength of Laterite, Rammed earth, & CEB at saturated / wet state.

6 Conclusion

In this study, LBS from Toussiana, Burkina Faso is studied for its hygroscopic and mechanical parameters. From sorption isotherm hysteresis and dynamic adsorption tests, laterite exhibits strong hygroscopic characteristics with MBV of 2.8g/m².%R.H, which is better than the SRE & USRE. It was also observed that the flexural strength and compressive strength of the LBS decreases with increase in moisture content, the flexural and compressive strength of the LBS at ambient conditions was found to be 0.55MPa and 2.4MPa respectively. Though the strength decreasing tendency is found with moisture, there is need for more experimental investigation to propose correlation of strength with moisture variation. Young's modulus of the specimens at ambient condition was found to be 2600 from cyclic loading, with plasticity of 20%. It was also seen that that the mechanical properties of LBS varies with quarry and region, hence it is highly recommended to study mechanical properties of laterite from each quarry. Further studies on chemical and mineral analysis of laterite would provide comprehensive analysis of LBS. The dry and wet compressive strength of laterite is on par with the stabilised earth construction materials, yet it exhibits a strong buffering capacity. In the light of this research laterite stone block as an eco-friendly and low cost building material seems to be a valid alternative solution. Furthermore, the natural induration that occurs during its formation could prove through further investigation to be a stabilisation solution for earth materials. This could widen the research on eco-friendly soil stabilisers used for stabilising earthen building materials.

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