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Development of Water Repellent Polish for the Pointing and Finishing on NBRRI Earth Block Walls

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Abstract:- Assessment of the challenges facing the adoption and promotion of NBRRI CSEBs reviewed the issues of instability or erosion of the brick wall surfaces, a case study reveals that it is a common problem to all walls made of this block within different zones of the country. The quest to proffer sustainable solution to these challenges necessitated this research work.

The study aimed at producing a locally sourced water repellent polish for painting and finishing on NBRRI earth block walls. A substance (slurry) that can resist moisture penetration into adobe walls through the surfaces. The materials used were sourced from the rainforest zone of the country, investigated and tried with different mix ration depending on the Oxide composition in phases. The first phase featured the following materials and equipment; limestone, crab soil, periwinkle shell, Termite mould, natural clay, Hydrated lime (Ca (OH)2, Soluble Rubber (Top Bond) and

Distilled water for mixing. Equipment includes; Weighing balance of 0.1g accuracy, sieve no 2020 (75pm) stirring rod, brushes and spray. In this phase soluble rubber was tried differently with the materials in various oxide composition applied on the existing CSEB walling unit, from observation some performed well while others performed moderately. The second and the third phase of the trial employed limestone and hydrated lime (Ca (OH)2 as the main stabilizer to activate reaction between the combination of any of the samples that contained high silica and a certain percentage of aluminium oxide (Al2CO3) x H2O(c) to produce an effective result as the Ca (H2O(s)) react in the presence of air to give Ca2SiO3(s) a solid that is stable in water, and applied on CSEB wall surfaces for observation across wet and dry Season.

Keywords:- *Brick Wall, Oxide Composition, CSEB, Wall Finishes.*

I. INTRODUCTION

Building with earth, an age-old construction technique, is regaining attention for its sustainable benefits in modern architecture. One of the primary challenges with earth-based construction is the susceptibility of the material to water damage. The ingression of moisture can lead to the deterioration of structural integrity, particularly in climates with high humidity or frequent rainfall. As such, the technology to protect earthen structures with an external coating that acts as a barrier to moisture is critical for long-term durability. This protective coating, in the form of a water-repellent polish, is designed to serve as a membrane that limits the penetration of water while preserving the structure's thermal properties and mechanical stability.

The Nigerian Building and Road Research Institute (NBRRI) has pioneered the development of compressed stabilized earth blocks (CSEBs), which have emerged as an eco-friendly and cost-effective alternative to conventional walling materials like concrete. NBRRI CSEBs, in particular, have demonstrated excellent compressive strength, thermal insulation, and aesthetic appeal, aligning well with the growing demand for sustainable building solutions in Nigeria and beyond. However, the issue of moisture ingression remains a significant concern, especially in regions with heavy rainfall. Addressing this challenge is crucial for ensuring the longevity and performance of earth block walls.

Previous studies, such as those by Danjuma (2018), have already established that NBRRI CSEBs meet the required walling standards in terms of strength and thermal performance. However, integrating a water-repellent polish for pointing and finishing presents an opportunity to enhance their resilience further. By developing such a protective coating, it is possible to extend the lifespan of these structures, reduce maintenance costs, and improve their overall performance in diverse climatic conditions. This approach not only makes the technology more practical but also aligns with global trends toward environmentally conscious construction methods, offering a pathway to sustainable, durable, and affordable housing solutions.

The aim of this study is to develop a locally sourced water-repellent polish for the pointing and finishing of NBRRI CSEB walls. To achieve this, the following objectives are pursued:

- Identify materials with low water absorption properties that can be sourced locally.
- Determine the oxide composition of the identified materials to understand their chemical properties.
- Utilize the oxide composition to inform the appropriate mixture ratios for developing the water-repellent polish.
- Apply the resulting mixtures to existing CSEB walls and monitor their performance in terms of water resistance and durability.

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This research aims to build on the proven success of NBRRI CSEBs by focusing on the development of a water-repellent polish that will protect earthen walls from moisture ingression while maintaining their structural and thermal efficiency.

➢ *This Study is Executed in Two Stages:*

- Review of literature
- Experimentation (application of surface finishes on walling unit)

II. PROBLEM STATEMENT

Moisture movement in building materials with high porosity when used for construction may expand slightly in wet and dry conditions. Such movements may result in cracks and other defects to the building. Expansion of stabilised earth blocks may vary according to the properties of the soil; some soils expand or shrink more than others. The addition of a stabilizer will reduce this expansion.

Generally, there may be greater movement in structures built with compressed stabilised earth blocks than those using alternative construction materials.

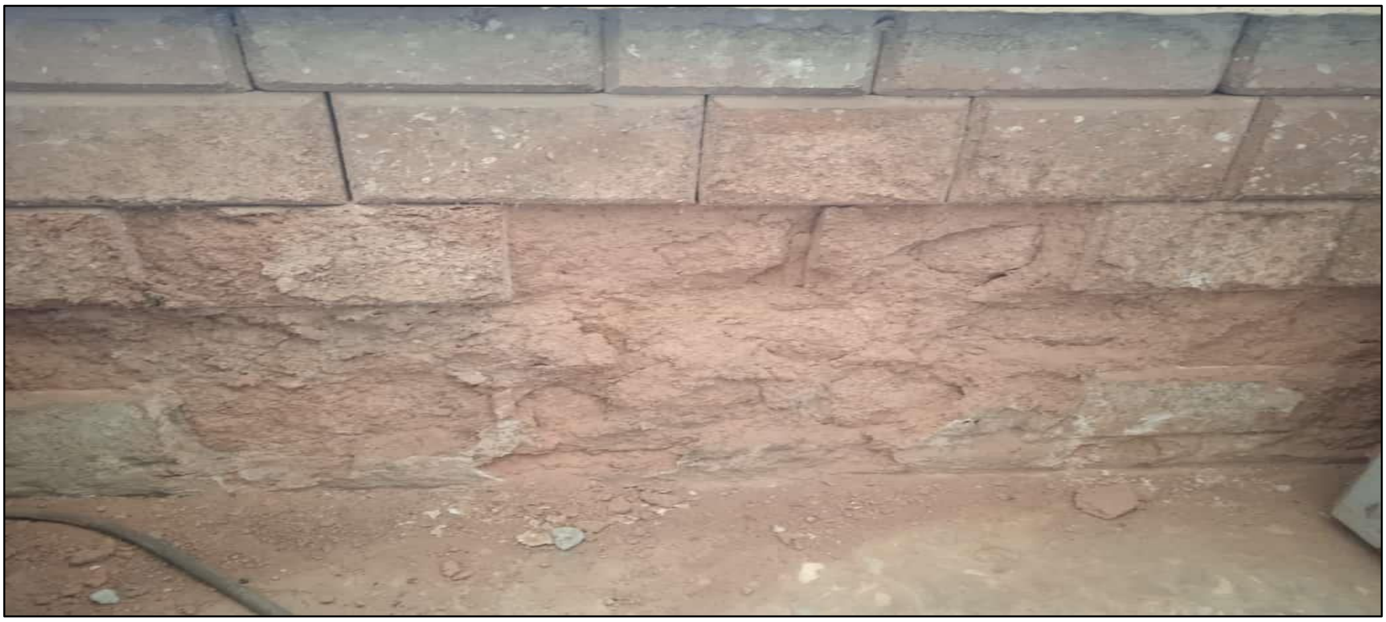

Plate 1: Deteriorated CSEBs Wall

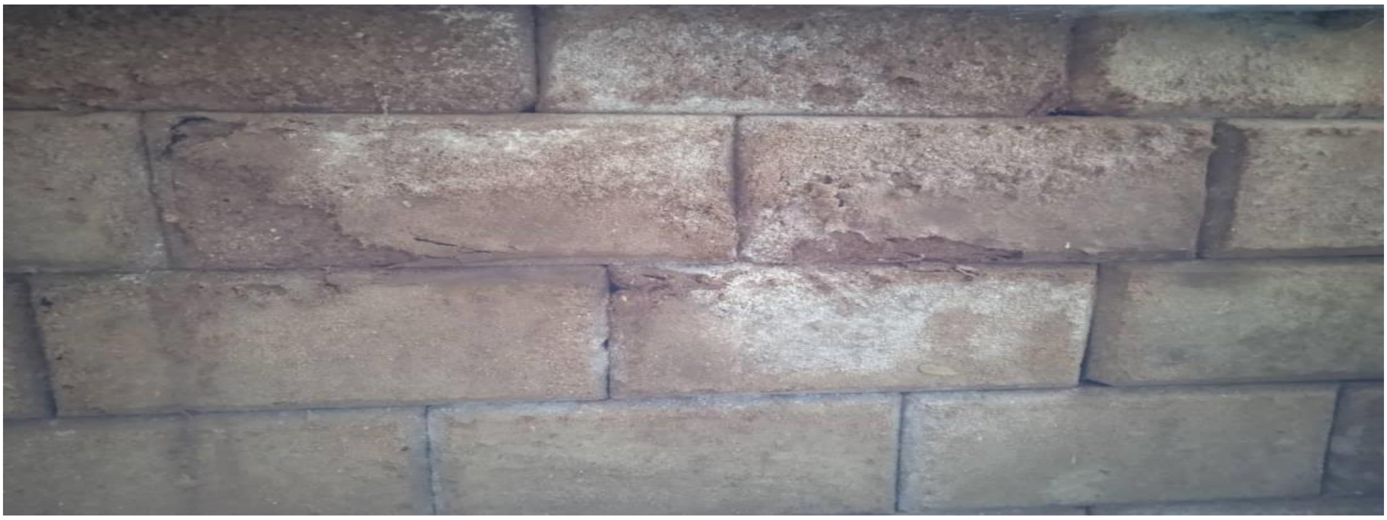

Plate 2: Deteriorated CSEBs Wall

III. MATERIALS AND METHODS

- The materials used for this research is enumerated below:
- Weighing balance of 0.1g accuracy
- Sieve No. 200 (75µm)
- Soluble rubber (Top bond)
- Limestone (Passing 75µm)
- Crab soil (passing 75µm)
- Termite mud soil (passing 75µm)
- Natural clay (passing 75µm)
- Periwinkle shell ash (passing 75µm)
- Hydrated lime (Ca (OH)2) < 30µm

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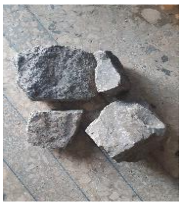
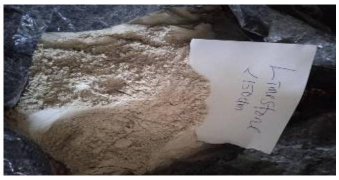
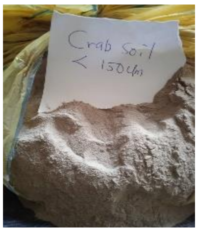
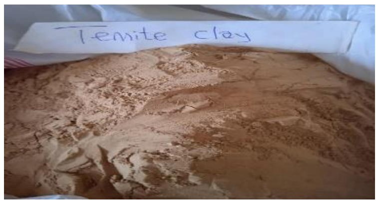
- Brushes for manual application
- Stirring rod for mixing
- Distilled water for mixing.

Table 1: Presentation of the Materials Sample Used

S/No	Name of Sample	Natural form of Sample	Fine Sample (Passing 150- 75
1	Laterite		
2	Limestone		
3	Crab soil		
4	Periwinkle Shell		
5	Termite Soil		

IV. METHODS

The method adapted is the combination of either material and the quantity of water was driven by the oxide composition of the materials.

The chemistry of suitable combination of oxides or elements that may give stable products to resist moisture movement in and out the CSEBs was taken into account.

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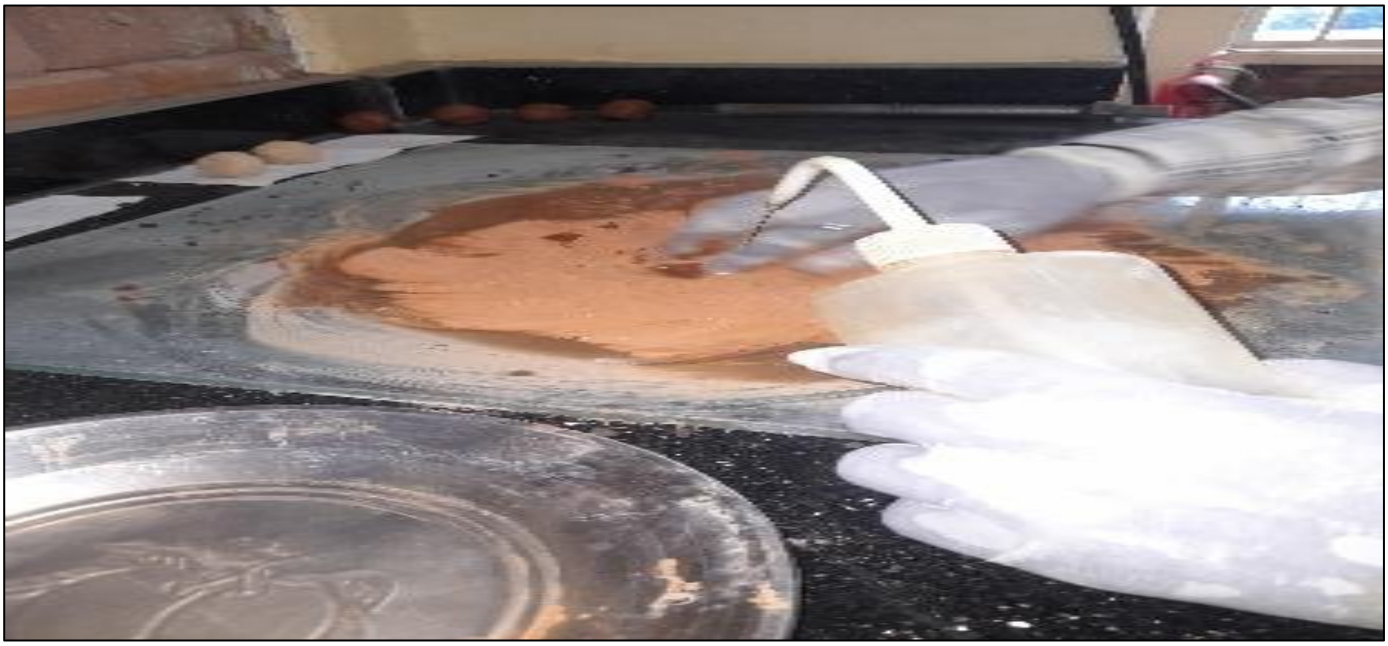

Plate 3: Adding Water to Sample

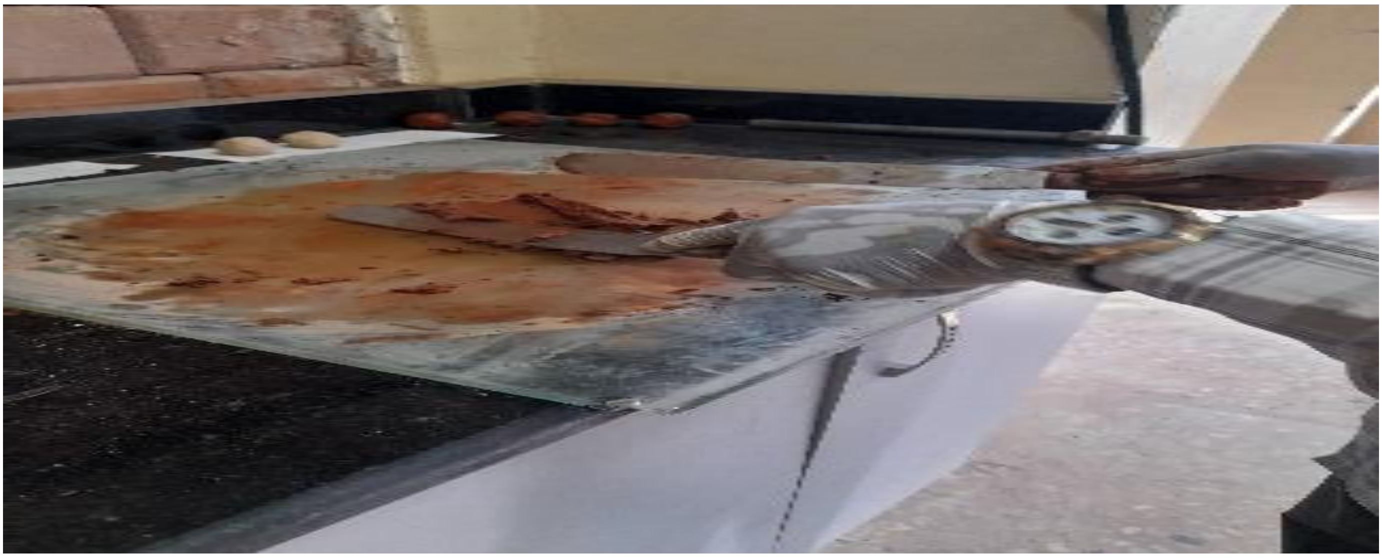

Plate 4: Mixing of Sample

Plate 5: Mixtures of Samples Paste

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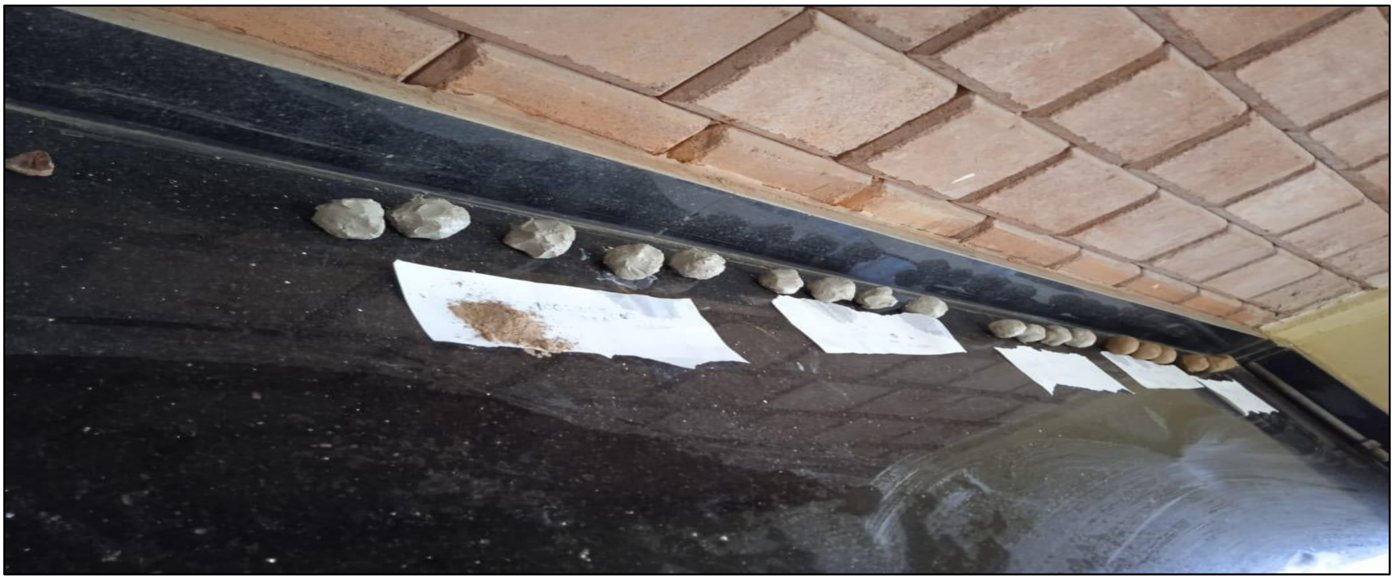

Plate 6: Dry Sample after 72hrs

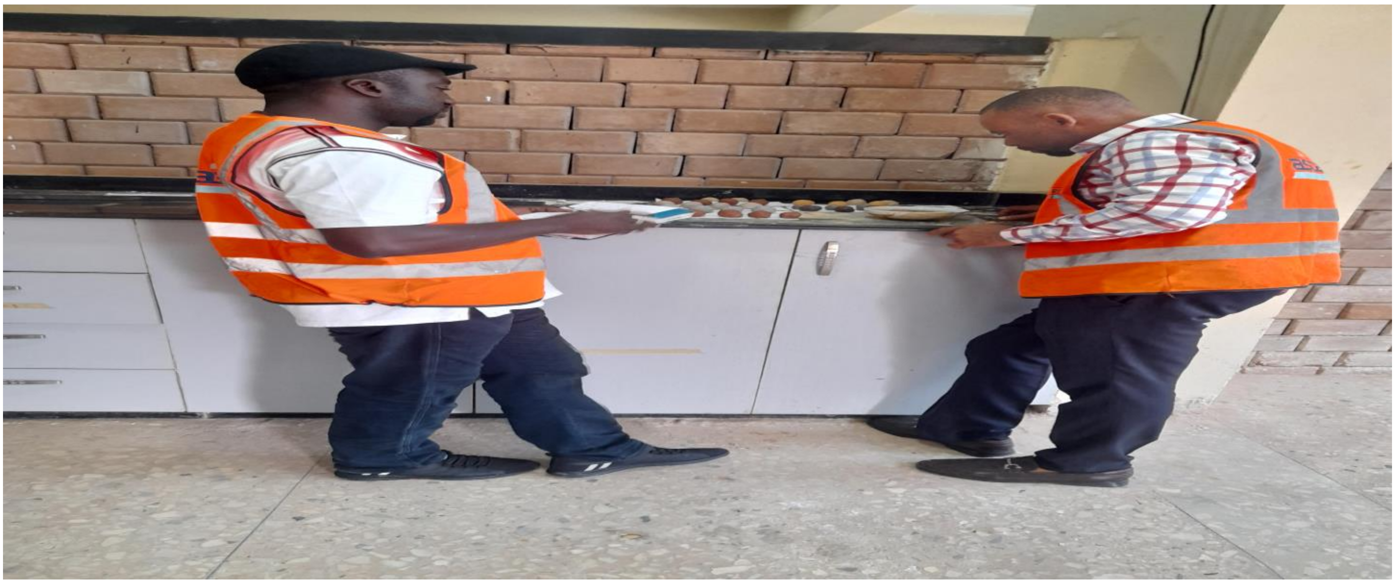

Plate 7: Taking Record of Samples

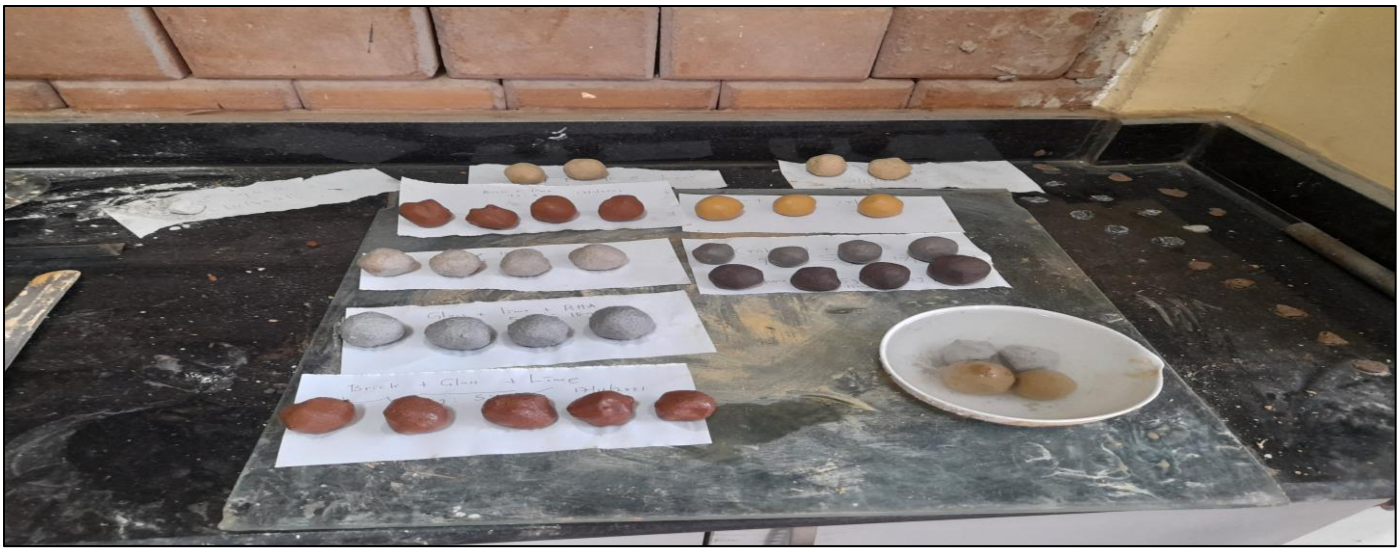

Plate 8: Soaking of Samples in Distilled Water

Chemical composition of materials considered for finishing. The chemical properties of materials derived from either soil, or calcined organic waste were tested for oxide composition and reactivity rate pattern using XRF and XRD respectively as shown in Table 3, from Umaru Musa Yar'adua University Katsina. See table 2 below.

Table 2: Presentation of Measure Oxides in the Materials Considered

Sample Name	Oxide Composition	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO
Crab soil	Oxide composition (%)	63.771	12.944	1.196	0.579	2.370
Natural clay	Oxide composition (%)	75.801	10.516	1.687	0.683	3.570
Termite clay	Oxide composition (%)	58.490	13.445	4.414	0.217	2.650
Limestone	Oxide composition (%)	8.609	3.152	0.459	72.731	1.940
Periwinkle shell	Oxide composition (%)	0.26	0.147	0.349	30.765	0.541

V. RESULTS AND DISCUSSIONS

Based on the chemical composition of the materials enumerated above, the combination of possible materials that could react and prevent moisture ingression was carefully selected and reacted with pure Ca (OH)2 known a hydrated lime. The proportions that performed very satisfactorily was 1:9 and 0.5: 9.5 translating to 90 and 95 respectfully.

Mixtures that contain high un-calcined silica (SiO2) from the oxide composition test resulted in cracking after application barely 24 hours of application. Mixtures that contain medium silica content and high Aluminium oxide when reacted with water and applied performed satisfactorily. Mixtures with low silica and Aluminium oxide mixed with a soluble rubber (top bond) produces excellent results but have flash setting time problem.

Mixtures without silica contend but with significant amount calcium oxide and 2.5% soluble rubber (top bond) produced very convincing results. The major limitation of soluble rubber is its ability to retain flash set immediately after application. Finally, in literature the emphasis and the production of CEBs is done with compatible stabilizers, finishing and durability of the blocks is a function of the right stabilization.

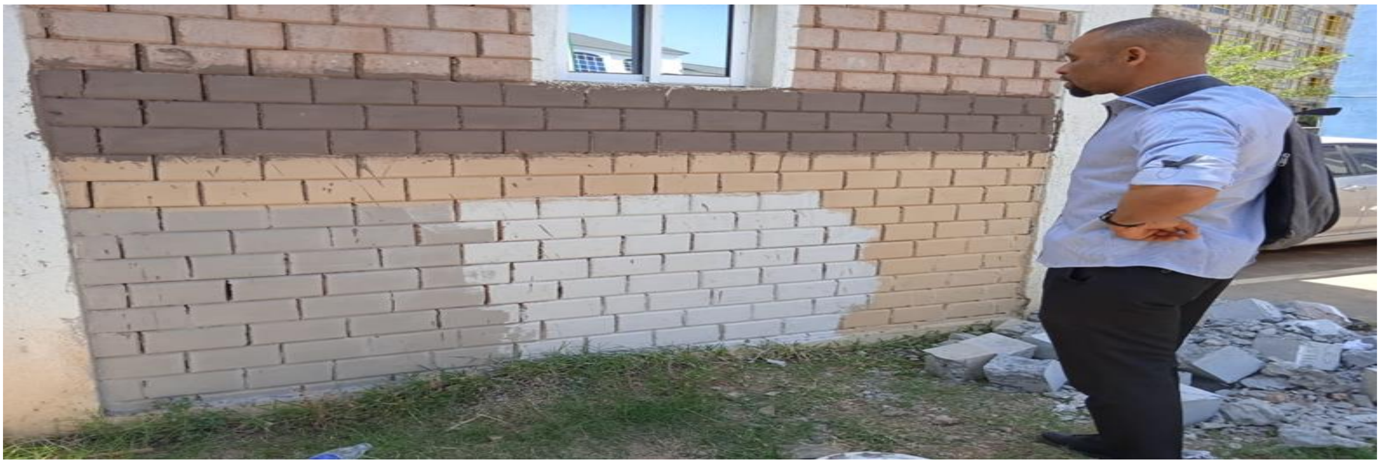

Plate 9: Observation of Samples after Polishing the Surface

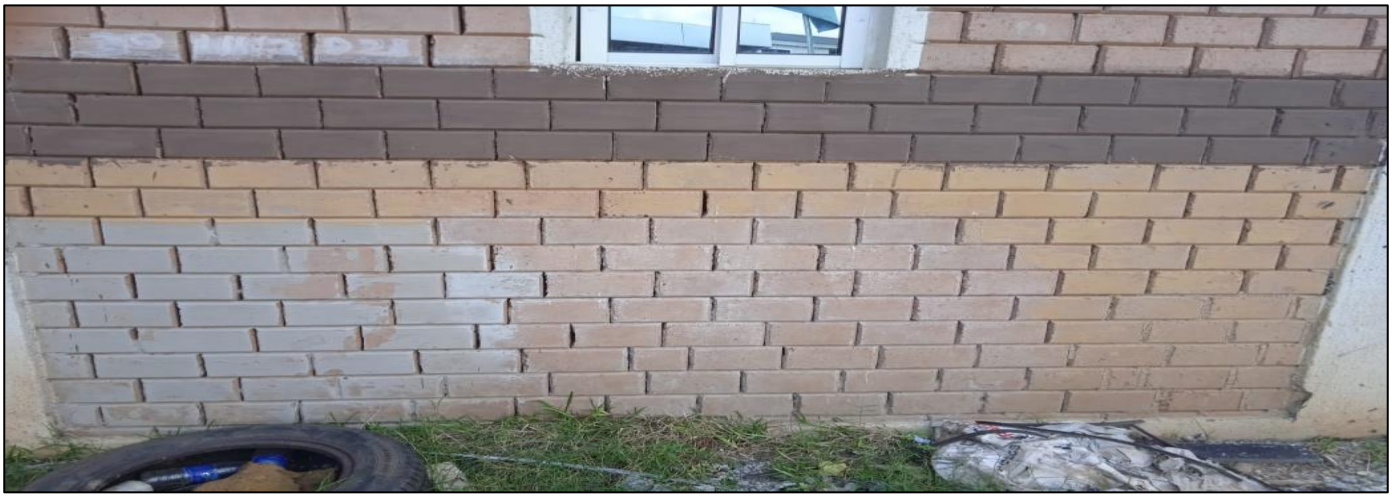

Plate 10: Observation of Samples after Three (3) Months of Polishing the CSEBs Wall Surface

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Table 3: Presentation of Sample Optimal Performance

Soil Sample	**Observation**
Crab soil	Reaction with hydrated lime mix with 60% water by weight produced a good result.
Natural clay	Reactions with natural clay by adding either limestone or hydrated lime resulted in cracks after drying. It was therefore eliminated from the trials.
Termite clay	Reactions with hydrated lime resulted in a mix resistant to moisture ingress at the water content of (65%). The trials performed satisfactorily.
Limestone	The limestone could only react properly with calcined rice husk ash 8000C + 5% of hydrated lime to produce a very tough coat within 24hrs. the result is outstanding.
Periwinkle shells/palm kernel ash	This class could not react much vigorously with hydrated lime nor limestone, however the reactions between these materials and a viscous rubber at 5% and water content of 70% produced an outstanding bound which is still under observation.

VI. CONCLUSION

The use of silica rich materials for developing finishing and polish to produce a protective cover to resist moisture ingression. The Nigerian Building and Road Research Institute (NBRRI) previous works are suffering from various degree of durability deformities, this research has proffered remedy and further intend to test the various workable mixtures on standard compressive earth blocks in-situ make the use of CSEBs more attractive hence materials for making CSEBs are ubiquitous. The mix ratio that satisfies the best mix is presented as $SiO_2(s) + CaO(s) + H_2O \rightarrow CaSiO_3(s) + H_2O(l)$.

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