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CAPILLARY ABSORPTION OF NBRRI INTERLOCKING COMPRESSED STABILIZED EARTH BLOCKS

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ABSTRACT: *Buildings constructed without an adequate damp-proof membrane are usually affected by a lot of problems and capillary action is one of them. Continuous research and development of stabilised earth, taking into account; its socio-economic concerns, structural suitability and environmental friendliness as a contemporary walling material have been an issue of growing interest. NBRRI has invested a lot of research time and effort in the development of CSEB technology. This CSEB when used for construction is subjected to conditions that expose it to water and sound. All these conditions are important considerations when designing and constructing a building for a particular purpose. Therefore, this study was aimed at producing standard NBRRI CSEB to investigate the coefficients of capillary absorption. The laterite used for this study was sourced in Jos, Plateau state. And also Dangote ordinary Portland cement was used for the stabilisation. The results show that an average amount of water absorbed within 10 minutes of exposure is up to a tenth of the block's total mass, indicating high water absorption at 5% cement stabilisation of the classified silty sand used.*

KEYWORDS: Capillary Absorption, Dampness, NBRRI, CSEB and Jos

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INTRODUCTION

Background of Study

Building is generally an essential facility for human living. Yet in it are some peculiar challenges. One of which is the presence of water i.e. dampness due to capillary action, which is one of the main decay factors in buildings (Bakolas et al, 2016). This work, therefore, will determine the capillary absorption of NBRRI interlocking compressed stabilised earth blocks produced with Laterite sourced in Jos, Plateau state used as a walling material. These blocks are used for both load-bearing and non-load-bearing walls of the building. NBRRI Interlocking CSEBs has shown a decrease in the negative environmental impacts of the construction activities and also ensured the sustainability of construction. Using NBRRI Interlocking CSEBs for construction, the resulting buildings will not only reduce the negative environmental impact and be more economically sustainable, but perhaps it will be more resilient when exposed to environmental elements and provide a more comfortable internal environment for occupants.

Water can reach a building material through the material pores in several ways (Bakolas et al, 2016). Rising dampness occurs in buildings due to capillary action which is the suction of moisture from the ground surrounding the structure into the vulnerable and porous building materials such as blockwork, brick, concrete and mortar works (Kportufe, 2015). Capillary action results from rising dampness from the surface and groundwater. It occurs due to improper use or lack of a damp-proof membrane (DPM) in protecting the structure from the incursion of moisture (Fakere and Folorunso, 2014). And also, it is the attraction of a liquid to solid surfaces i.e. a phenomenon in which a liquid surface rises, drops or becomes distorted in shape when it is in contact with a solid or a semi-permeable membrane (Fakere and Folorunso, 2014). Capillary action occurs when building materials soak up water from the ground (Fakere and Folorunso, 2014). In his work, Kportufe (2015) highlighted some essential causes of the rising dampness in the building which are:

1. Failure to provide damp proof course
2. Failure to provide damp proof membrane
3. Failures of an existing damp proof course
4. High external ground bridging an existing D.P.C.
5. Internal plaster works bridging an existing D.P.C.
6. Bridging of damp proof course due to a buildup of mortar works inside a cavity wall.
7. Leaking water pipes at the base of a wall.

To provide solutions for the above causes of rising dampness in buildings; Kportufe (2015) suggested because of their complexity, that specialist-trained professionals will be needed to carry out the investigation and survey works before a solution can be provided. Rising dampness in the building, on the other hand, have several effects on different parts of the building where it is evident. Some of these effects are highlighted by Kportufe (2015) as:

Effects of dampness in buildings

1. Causes routing of doors and window frames.
2. Causes corrosion of reinforcing bars and metallic fixtures.
3. Causes bleaching and blistering of paints above the internal and external surfaces.
4. Causes petting off and removal of plaster tiles even terrazzo works.
5. Causes sports and stains on the floors and walls.
6. Deteriorate carpets, skirting boards, dado rails and furniture.
7. Deteriorate electrical installations.
8. Causes efflorescence.
9. Causes health-related problems to occupants.
10. Reduce the life span of the structure.

Prevention of rising dampness due to capillarity action

Some of the materials are used as additives to the base materials during production to enhance their resistance to wetness, while others are used directly in the building as sealants (Fakere and Folorunso, 2014). Folorunsho (2010) and Fakere and Folorunso(2014) highlight some of these materials that are used in Nigeria for the prevention of the rising dampness in the buildings including but not limited to the following:

1. Epoxy plastics
2. Silicone-Based Waterproof
3. Polymer
4. Bituminous sealant
5. Polyurethane sealant

Nigerian Building and Road Research Institute (NBRRI) is an agency under the federal ministry of science, technology and innovations. NBRRI is saddled with the Mandate which includes conducting research on; local building and construction materials to determine the most effective and economic methods of their utilization (www.nbrri.gov.ng, visited on 01/12/2022). NBRRI has other roles which constitute its mandate, but this workpiece is beamed out of the mentioned above. Much has been invested by NBRRI in the research and development of compressed, stabilised earth blocks (CSEB) technology, which includes the design and fabrication of its production machines, production techniques and wall construction techniques. Several studies such as Maton et al (2014) and Didel et al (2014) have suggested NBRRI CSEB technology possesses a comparative advantage over other conventional walling materials with respect to cost and environmental friendliness. Nonetheless, the water absorption as an index of the durability of the block at 5% stabilisation becomes necessary. Onaolapo (2010) reported that suitable laterite for block production would be composed of clay of 15-20 per cent, containing silt of roughly 25-40 per cent by volume and roughly 40-70 per cent by volume of sharp sand. Like every other building block, NBRRI CSEB used for construction may be subjected to conditions that expose it to water which is a major cause of wall dampness as a result of capillary absorption of the water through the blocks. Therefore, the absorption coefficient determined in this study indicates the speed of absorption of a block after 10 minutes of partial immersion. The absorption coefficient measured after 10 minutes is a way of characterising a material which is already in use for other small masonry elements.

Building with earth has been in existence since the earliest stages of human civilization as seen in the histories of ancient Egypt and Mesopotamia. (Jagadish, 2007). Studies by Riza et al(2011) show that this age-long material has also become a subject of renewed interest, especially in developing countries which are faced with the challenge of meeting the housing needs of their growing population. Hence, the continuous research and development of stabilised earth, taking into account; its socio-economic concerns, structural suitability and environmental friendliness as a contemporary walling material. The National Building Code (2006) recommends that cement–stabilised blocks should be composed of suitable soils stabilised by ordinary Portland cement of not less than 5% by weight and compressed by a minimal pressure of 3N/mm2. Just like this study; a study by Didel et al (2014) shows that NBRRI in compliance with the foregoing building code has been involved in the development of an interlocking Compressed Stabilised Earth Block (CSEB) that requires no mortar for bonding, rather using a lateral and posterior interlocking of alternate groves and tongues to form a wall.

Aim and Objectives

This study aims to characterise NBRRI CSEB produced at 5% stabilisation with a machine compaction effort of 20MPa.

This will be achieved through the following set objectives:

1. To produce the blocks according to NBRRI standard formulation.
2. To cure the blocks for 21 days.
3. To compute the coefficient of capillary absorption of the block from test results.

MATERIALS AND METHODS

Materials

The materials and pieces of equipment used for this study were locally sourced in Jos, Plateau state in Nigeria, NBRRI laboratory and workshop.

They are under-listed:

i. Laterite,

ii. Ordinary Portland cement

iii. Water fit for drinking

iv. Silica desiccating gel.

v. NBRRI CSEB Moulding Machine

vi. Laboratory Oven

vii. Water Bath

viii. Knife edge

ix. Weighing Balance etc.

Method

The blocks were produced using the CSEB moulding machine having 20Mpa effort. The moulded blocks were then cured for a period of 21 days, by means of covering them with polythene. For the water absorption test; the cured block samples were partially immersed in a water bath at about 5mm of the height of the block at normal room conditions for a period of 10 minutes. Conditions were such that all the block samples were immersed to this same height in accordance with the standard ARS 674, 675, 676 and 677. The water absorption values were expressed in percentage mass. This value is one of the standardized classifications for CSEBs to be taken into account. It was checked for the correspondence to the absorption capacity to saturation of a block in a capillary absorption situation after several days.

RESULT AND DISCUSSION

Table 1: Capillary Absorption Coefficient of NBRRI CSEB

Sample	A	B	C	D	E	F	G	H	I	J
Length (L) in cm	23	23	23	23	23	23	23	23	23	23
Width (W) in cm	17.3	18.2	17.5	17.5	18	17.5	18.5	17.8	17.5	18.1
Surface Area (S=LxW) in cm2	397.9	418.6	402.5	402.5	414	402.5	425.5	409.4	402.5	416.3
Dry Mass of Sample (md) in g	6883.4	7126.3	6943.7	6891.4	7014.8	6821.9	7063.2	6879.4	6827.7	6953.7
Mass of Sample after 10 minutes of partial immersion (m’[) in g	7005.1	7310.1	7070.7	6995.8	7174.1	6943.6	7234	7017.7	6928.7	7102.2
Mass of water absorbed = (mw – md) in g	121.7	183.8	127	104.4	159.3	121.7	170.8	138.3	101	148.5

Coefficient of Capillary Absorption, $Cb = \frac{100\ x\ (Mw - Md)}{S\sqrt{10}}$	9.67200782	13.885	9.97787	8.20228	12.1679	9.56147	12.6937	10.6825	7.93516	11.2803
Average Cb	10.60582141									

The result from the Table 1 above shows that the average coefficient of capillary absorption of the NBRRI CSEB is 10.61. This, therefore, means that an average amount of water absorbed within 10 minutes of exposure is up to a tenth of the total mass of the block as shown in Table 1. This indicates high water absorption at 10% cement stabilisation. Hence, the block should not be used for the foundation in swampy environments without plaster. Adherence to the above will increase the durability of the building. The absorption coefficient was computed which corresponds to the speed of absorption of water by the CSEB. This value is more representative of the behaviour of masonry elements subjected to capillarity rise and rain splashes than the elements' absorption capacity measured at saturation.

CONCLUSION AND RECOMMENDATIONS

Conclusion

Having water absorption as a determinant of the durability of a building, the CSEB produced at 5% stabilisation and 21 days curing showed significant absorption up to one-tenth(1/10) of its mass within the briefest period of exposure to water.

Recommendations

- CSEB that will have high exposure to water should be plastered or have the proportion of the cement constituent increased.
- Other curing periods should be considered for similar investigations.

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