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EFFECTS OF GUM ARABIC ON THE MOISTURE CONTENT AND WATER ABSORPTION OF LATERITIC BRICKS OF VARYING PARTICLE SIZES OF FINE AGGREGATES

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Abstract

The increasing greenhouse gas emissions associated with construction, accounts for 37% global emissions. In mitigating these challenges, the Nigerian Building and Road Research Institute (NBRRI) recommends the use of lateritic bricks due to it's environmental sustainability. To achieve durability and environmental sustainability, Gum Arabic is introduced in laterite soil to improve its properties. The objective of the study is to determine the suitability of Gum Arabic as stabilizer on the moisture content and water absorption capacity of earth bricks of different particle size distributions.

Experimental research method was adopted for the study. The particle size distribution of the laterite soil was classified within the ranges 75µm-600µm, and 1.18mm-4.76mm. Also, the content of the Gum Arabic was proportioned

Key words:
Environmental Sustainability,
Lateritic Bricks,
Gum Arabic,
Moisture Content,
Water Absorption.

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from the range of 0% to 30% partial replacements. Sample bricks were produced and tested at 14, 21 and 28 days curing period. The data collected from the results of the laboratory experiments was analysed using bar charts. The results showed that, particle size distributions for grading fine aggregate suitable for compressed stabilised earth bricks (CSEB) was found to be between 1.18mm-4.76mm considering it low extent of permeability and high durability properties at 28 days curing period. It was concluded that, moisture content influences the rate of water absorption, such that an increase in moisture content consequently increases the rate of water absorption. However, the low extent of water permeability recorded, reduces the water content in the pores of the CSEBs, thereby reducing the extent of expansion and contraction making the GA-based CSEBS to be less brittle and more durable. It was recommended that, when selecting eco-friendly bricks for construction of buildings, Gum Arabic based Compressed Stabilised Earth Bricks (GA-based CSEBs), should be utilised considering its low permeability and durability for particle size > 600μm.

Introduction

Background

The combustion of fossil fuels for processing construction materials and the construction process itself makes the environment unsustainable. During the construction stage of buildings, the use of construction plants and the combustion of fossil fuels for heating, cooling and lighting up of buildings during the habitation stage account for over 37% of global carbon emissions into the atmosphere (United Nations Environment Program, 2023). In mitigating these environmental challenges, lateritic bricks are being utilized and are considered as eco-friendly construction materials. Laterite earth is considered as one of the oldest building materials used for making compressed earth (laterite) bricks. Bricks made from laterite are environmentally friendly, cost effective, less energy consumption, less waste and sustainable building materials that serve as alternative to sand-crete blocks (Oyelami & Van Rooy, 2016; Ibrahim, Magindran, Shahrin, & Yusof, 2020). Raheem, Momoh &

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Soyingbe (2012), posits that compressive strength of laterite brick was found to vary from 1.70N/mm^2 - 5.03N/mm^2 at 7-28 days compared to sand-crete block varying from 1.59N/mm^2-4.25N/mm^2 at 7 to 28 days, which makes laterite brick a more durable construction material for the production of buildings. However, laterite soils use for producing lateritic bricks lack strength, durability, and stability. To improve the properties of the lateritic soil, both mechanical and and chemical stabilization are required through the process of compaction to remove air voids and introducing additives to stabilise the soil before producing compressed stabilised earth bricks (Malkanthi, Balthazaar & Perera, 2020).

To mitigate these defects, organic additives such as Gum Arabic is added to improve its engineering properties. Gum arabic as dried exudates obtained from trees called Accacia Senegal. It is a naturally occurring organic vegetable fusing agent that serves as stabilizer in enhancing laterite soil (Lelon, Jumba, Keter, Chemuku and Oduor, 2010). Gum Arabic is a sustainable and environmental friendly organic additive, used for the production of building materials. It has water-reducing properties, increases compressive strength and has high inter-molecular bonding effect (Mbugua, Salim & Ndambuki, 2016). Gum Arabic has a density of 1.35-1.49. It has a boiling point greater than 250 degrees centigrade and a melting point of 0-100 degree centigrade. Gum Arabic is odourless, with a glassy appearance and an emulsifying property of 30%, and it is soluble in water (Taimiyu, Adebayo & Yusuf, 2023).

Rimberngaye, Mwero & Ronoh (2022) observed that increasing the content of Gum Arabic also increases the engineering properties of compressed laterite bricks. On the other hand, British Standard BS 812 (1985) posits that particle size distribution (grading for fine aggregate) affects the engineering properties of bricks such that, the properties vary in particle sizes less than 600µm from particle sizes greater than 600µm. Similarly, Oyelami & Van Rooy (2016) established that laterite with uneven fine and coarse particle size distribution affects the engineering properties the bricks such as moisture content and water absorption. The gap in these empirical studies was

identified as lack of establishing the required optimal content of Gum Arabic to be used as organic stabilizer in producing compressed stabilised earth bricks CSEB from lateritic soil of varying particle size distribution of fine aggregates. It is on the basis of this background that the study sets out to explore the use of Gum Arabic as organic stabilizer in the production of compressed stabilised earth bricks CSEB as eco-friendly construction material for housing delivery needs in Nigeria.

Literature Review

Gum Arabic

Gum Arabic is a natural organic viscous sealant material. It is a solid substance that is soluble in water and are majorly of two types, namely Acacia Senegal and Acacia Seyal (Satti & Ahmed, 2018). Gum Arabic is obtained as exudates of acacia Senegal. The exudates are non-viscous liquid, rich insoluble fibers, and its emanation from the stems and branches usually occurs under stress conditions such as drought, poor soil fertility, and injury. Chemically, Gum Arabic is a mixture of macro molecules of different size and composition (carbohydrates and proteins). The properties and features of Gum Arabic is used in a wide range of industrial sectors such as; textiles, ceramics, lithography, cosmetics and pharmaceuticals, encapsulation and food (Lelon, Jumba, Keter, Chemuku & Oduor, 2010; Montenegro, Boiero, Valle, & Borsarelli, 2012).

Compressed Earth Bricks

A compressed earth brick (CEB), is a building material made from an appropriate mix of inorganic laterite soil. It involves dampening, compaction at high pressure, and drying. However, when the bricks are stabilized using an additive they are called compressed stabilized earth brick. Compressed stabilized earth bricks present tremendous number of advantages such as; increases the utilization of locally sourced material, reduces cost of transportation, makes quality housing available, low level of waste, less

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environmental pollution, absorb atmospheric moisture which creates healthy indoor environment for the building occupants, thermal insulation, acoustic insulation, and reduced energy consumption (Razman, Abdullah, Md Noh & Abd Wahid, 2010; Riza, Abdul Rahman, & Zaidi, 2010).

Water Absorption and Moisture Content of Compressed Earth Bricks

Water absorption rate decreases as the compressed earth bricks increases in age. High extent of water absorption causes swelling of stabilized laterite soil fractions, resulting in loss of strength. Sand content in the mix reduces water absorption and weight loss even though does not affect the compressive strength significantly. Moisture contents affect strength development and the durability and have a significantin fluence on the stabilized laterite soil which affects bonding with mortar during construction (Riza, Abdul Rahman, & Zaidi, 2010; Mbugua, Salim & Ndambuki, 2016).

Materials and Method

The research method adopted for the study was experimental research method which was conducted by using two sets of variables to measure a scientific phenomenon. Laboratory experiments was conducted using lateritic soil and Gum Arabic as variables, such that as the first variable increases; the second variable reduces. The procedure for the laboratory experimentation was as follows;

Soil Preparation

The preparation of laterite soil for CSEB was as follows;

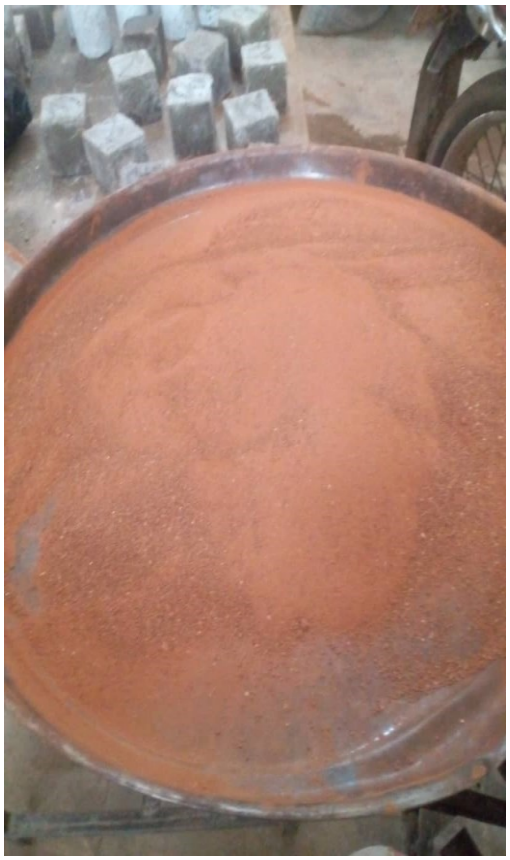
i. Extraction of laterite soil was done from the quarry site at Shika.
ii. Drying was done by spreading in thin layer or passing through hot-air cyclone in the laboratory.
iii. Pulverizing to break up lumps of clay.
iv. Screening was done to remove undesirable elements after general preparation.

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v. A known mass was used to measure the dried leteritic soil with all the grains properly separated out.
vi. A stack of sieves were set one over the other in an ascending order
vii. The sieves were clean, and the whole nest of sieves was given a horizontal shaking for 10 minutes
viii. The mass of soil retained on each sieve was determined including that collected in the pan below. The test results obtained from a sample of soil are given below. Mass of soil taken for analysis W = gm



Figure 1: 1.18mm-4.76mm particle size



75µm-600µm particle size

Preparation of Gum Arabic Additive

The procedure for preparing the organic Gum Arabic was as follows;

i. The Gum Arabic was dried using oven
ii. The dried Gum Arabic was crushed into fine particles
iii. The crushed particle of the Gum Arabic was sieved.

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iv. The Gum Arabic powder was diluted in water and allowed to properly dissolve for 24 hours.

v. The different percentage of partial replacements of Gum Arabic were diluted in water and marked in different containers.



Figure 2: Sample of Gum Arabic



Figure 3: Solution of Gum Arabic

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Batching and Mixing

The procedures for batching and mixing of homogeneous mixture of Gum Arabic and lateritic soil was as follows;

i. The laterite soil was measured by weight or volume, mixed with water and stabilizer.
ii. Dry mixing to maximise the effectiveness of the stabilizer which is in powder form.
iii. Wet mixing to add water by spraying after adequate dry mixing, or directly in form of liquid stabilizer.



Figure 4: heterogeneous mixture of Gum Arabic and laterite soil.

Production of Bricks and Curing/ Drying

The procedures for producing the compressed stabilised earth bricks (CSEB) was as follows;

i. The molds were be lubricated.
ii. The quantity of material was measured.
iii. The homogeneous mixture of Gum Arabic and lateritic soil were loaded into the molds.
iv. The homogeneous mixture was rammed to remove air voids using manual pressing machine.

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v. The bricks were removed from the mold.

vi. Wet curing was done depending on the climate and the nature of the stabilizer.

vii. Drying was done to achieve the required quality.

viii. Stacking of the compressed stabilized earth bricks to make ready for testing.



Figure 5: brick samples of 75µm-600µm



brick samples of 1.18mm-4.76mm



Figure 6: 10% GA bricks of 75µm-600µm



10% GA bricks of 1.18mm-4.76mm

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Figure 7: 20% GA bricks of 75µm-600µm



20% GA bricks of 1.18mm-4.76mm



Figure 8: 30% GA bricks of 75µm-600µm



30% GA bricks of 1.18mm-4.76mm

Water Absorption Test

Water absorption test for the GA-based CSEB is a hardened state test carried out to measure the quantity of water the bricks can absorb over a period of time while in a hardened state. The water absorption test was conducted 3 times (at 14, 21 & 28 days curing) on two separate categories of particle size distributions (75µm-600µm and 1.18mm-4.76mm) used for the GA-based CSEB with percentage replacements of 0%, 5%, 10%, 15%, 20%, 25% and 30%. The procedure was as follows:

i. The compressed stabilised earth bricks were weighed.

ii. The compressed stabilised earth bricks were immersed in water for a period of 24 hours.

iii. The compressed stabilised earth bricks were removed from water and the new weight was measured.

iv. The water absorption capacity was calculated using the formula W = Wa – Wb / Wb x 100 Where Wa is mass after absorption, Wb is mass before absorption.

Results and Analysis

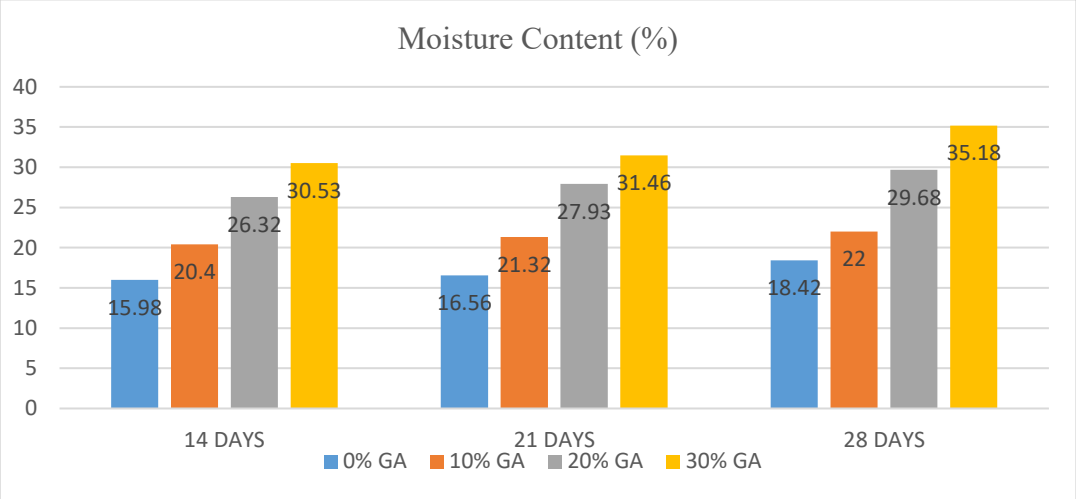


Figure 9: 75µm-600µm fine particle sizes.

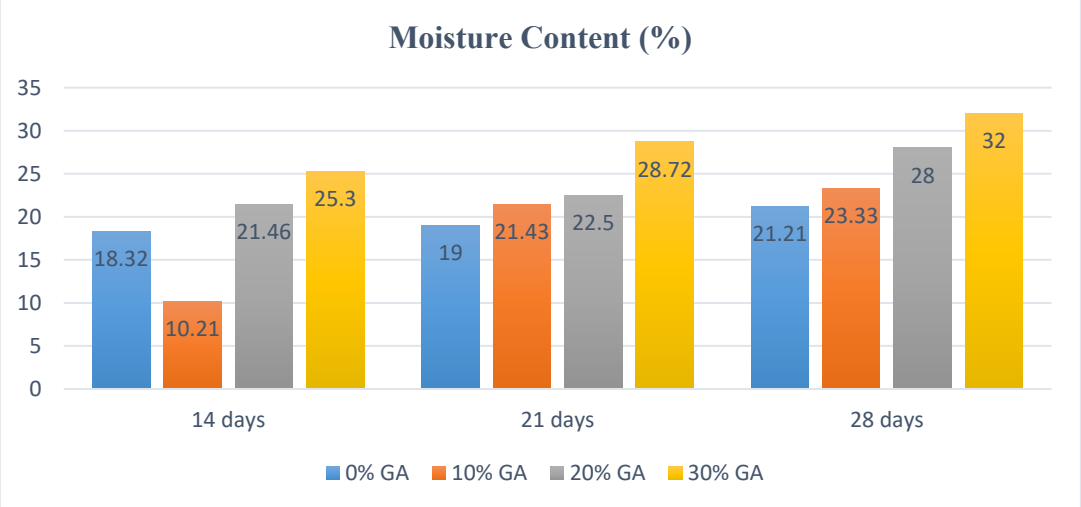


Figure 10: 1.18mm-4.76mm fine particle sizes.

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Fig 9, and 10 show the results of the moisture content of Compressed Stabilised Earth Bricks CSEBs for particle size distribution between 75µm-600µm, and 1.18mm-4.76mm, using Gum Arabic as partial replacement from 0% to 30%. The CSEBs were subjected to moisture content test in accordance to BS 812-109: 1990, at 14, 21, and 28 days curing period at the department of Building, Ahmadu Bello University, Zaria.

For GA- based CSEBs of particle size distribution 75µm-600µm, it was observed that at 14 days curing period, the following results were recorded such as 15.98%, 20.4%, 26.32%, and 30.53% with partial replacement of Gum Arabic at 0%, 10%, 20%, and 30% respectively. It can be seen that as the quantity of Gum Arabic increase, so does the moisture content increases. At 21 days curing period, the moisture content recorded had the following values; 16.56%, 21.32%, 27.93%, and 31.46% with partial replacements of 0%, 10%, 20%, and 30% respectively. It can be seen that the moisture content also increases with an increase in the content of Gum Arabic. At 28 days curing period, the moisture content observed had the following values; 18.42%, 22.0%, 29.68%, and 35.18% with partial replacement of 0%, 10%, 20%, and 30% respectively. It can similarly be seen that the moisture content increases with corresponding increase in the content of Gum Arabic. These values contradicts the study by Aguwa (2010), such that, the moisture content were found to be higher than the range of moisture content of 3.18% to 14.73% specified by the Nigerian Building and Road Research Institute (NBRRI). The reason for the high moisture content could be attributed to prolonged exposure of the CSEBs to moisture.

For GA-based CSEBs for particle size distribution of 1.18mm-4.76mm, it was observed that at 14 days curing period, the moisture content had the following values; 18.32%, 10.21%, 21.46%, and 25.3% with partial replacement of Gum Arabic at 0%, 10%, 20% and 30% respectively. The moisture content was seen to increase with corresponding increase in the quantity of Gum Arabic. At 21 days curing period, it was observed that the moisture content had the following values; 19.0%, 21.43%, 22.5%, and 28.72% with partial replacement of Gum Arabic at 0%, 10%, 20% and 30% respectively. The moisture content also increases with corresponding increase in the content of Gum Arabic. At 28 days curing period, it was observed that the moisture content had the following values recorded; 21.21%, 23.33%, 28.00%, and 32.00% with partial replacement of Gum Arabic of 0%, 10%, 20%, and 30% respectively. The moisture content was found to increase as

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the content of Gum Arabic was increased. Similarly, these values contradicts the study by Aguwa (2010), such that, the moisture content were found to be higher than the range of moisture content of 3.18% to 14.73% specified by the Nigerian Building and Road Research Institute (NBRRI). The reason for the high moisture contentment could also be attributed to prolonged exposure of the CSEBs to moisture.

In comparing, the moisture content of GA-based CSEBs for lateritic soil of different particle size distribution of fine aggregates (75µm-600µm, and 1.18mm-4.76mm), it can be seen that, the moisture content of both classifications particle size distribution increases with a corresponding increase in the quantity of Gum Arabic over time. At 28 days curing period, the highest moisture content recorded was 32.00% with partial replacement of 30% above 14.73% recommended value by NBRRI and equally contradicts the findings by Aguwa (2010). However, the gradual increase in moisture content aligns with the study by Sale and Bala (2010), such that, the percentage increase in content of Gum Arabic and the corresponding increase in water moisture makes the CSEBs to absorb more water that leads to gradual increase in optimum moisture content. By implication, any further increase in the quantity of Gum Arabic is likely to further increase the moisture content in the CSEBs. Furthermore, the high content of moisture could be attributed to long curing time, and makes the GA-based CSEBs susceptible to cavities, and loss of strength, which is likely to affect the durability of the GA-based CSEBs when used as building material.

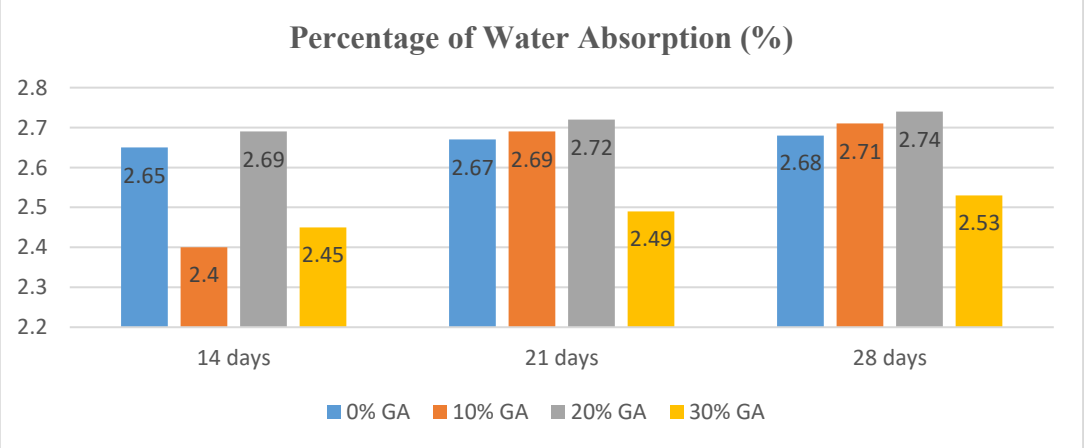


Figure 11: 75µm-600µm fine particle sizes.

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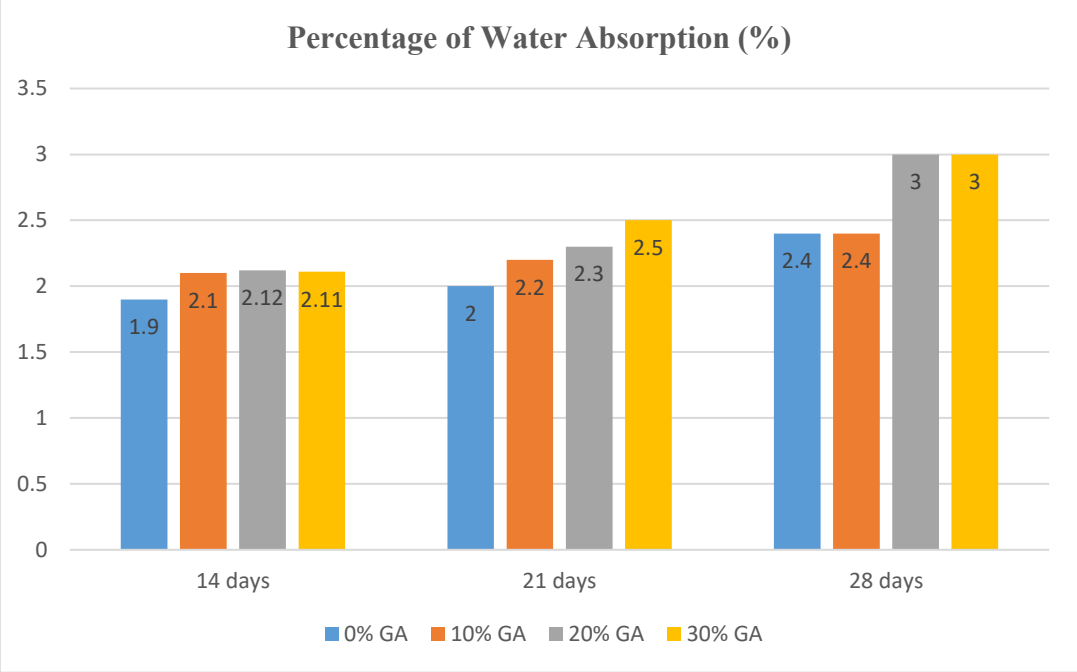


Figure 12: 1.18mm-4.76mm fine particle sizes.

Figure 11 and 12 show the percentage of water absorption coefficient of compressed stabilised earth bricks CSEBs for particle size distribution between 75µm-600µm, and 1.18mm-4.76mm, using Gum Arabic as partial replacement from 0% to 30%. The CSEB were subjected to water absorption test in accordance to BS 1881:122: 1983, at 14, 21, and 28 days curing period at the department of Building, Ahmadu Bello University, Zaria.

For particle size distribution between 75µm-600µm, it was observed that at 14 days curing period, the extent of water absorption was found to be 2.65%, 2.4%, 2.69% and 2.45% with 0%, 10%, 20% and 30% partial replacement of Gum Arabic respectively. It can be seen that the rate of water absorption decreases at 30% partial replacement, indicating an optimum level of 2.69% at 20% partial replacement. At 21 days curing period, it was observed that the extent of water absorption was found to be 2.67%, 2.69%, 2.72% and 2.49 % with percentage replacements of 0%, 10%, 20% and 30% respectively. At 21 days an optimum value of 2.72% was recorded at 20% percentage replacement. While at 28 days curing period, the extent of water absorption was found to be 2.68%, 2.71%, 2.74% and

2.53% with percentage replacements of 0%, 10%, 20%, and 30% respectively. Similarly it can be seen that the optimum value of water absorption reached was 2.74% with a percentage replacement of 20%. From the results obtained it can be seen that the rate of water absorption reduces as the Gum Arabic percentages increases. This is contrary to the findings by Sale and Bala (2010); Rimberngaye, Mwero, and Ronoh (2021), which states that as the Content of Gum Arabic increases, so does the rate of water absorption increases. However, when compared with the NBRRI standard requirements which is 12.5%, it can be seen that the optimum water absorption capacity of 2.74% is below NBRRI requirements. This indicates that there is low water permeability in the GA-based CSEBs.

For particle size distribution between 1.18mm-4.76mm, it was observed that at 14 days curing period, the extent of water absorption was found to be 1.9%, 2.1%, 2.12% and 2.11% with 0%, 10%, 20% and 30% partial replacement of Gum Arabic respectively. It can be seen that the rate of water absorption decreases at 30% partial replacement, indicating an optimum level of 2.12% at 20% partial replacement. At 21 days curing period, it was observed that the extent of water absorption was found to be 2.0%, 2.2%, 2.3% and 2.5 % with partial replacements of 0%, 10%, 20% and 30% respectively. At 21 days, an optimum value of 2.5% was recorded at 30% percentage replacement. While at 28 days curing period, it was observed that, the extent of water absorption was found to be 2.4%, 2.4%, 3.0% and 3.0% with partial replacements of 0%, 10%, 20%, and 30% respectively. Similarly it can be seen that the optimum value of water absorption reached was 3.0% with a partial replacement of 30%. From the results obtained it can be seen that, the rate of water absorption increases as the content of Gum Arabic increases. This is similar to the findings by Sale and Bala (2010); Rimberngaye, Mwero, and Ronoh (2021), which states that as the Content of Gum Arabic increases, so does the rate of water absorption increases. When compared with the NBRRI specified value of 12.5%, it can be seen that the optimum water absorption capacity of 3.0% is below. This indicates that there is low water permeability in the GA-based CSEBs.

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In comparing, the rate of water absorption for GA-based CSEBs for different particle size distribution of fine aggregates, it can be seen that, the rate of water absorption for the GA-based CSEBs with particle size distribution of fine aggregates between 75µm-600µm, and GA-based CSEBs with particle size distribution for fine aggregates between 1.18mm-4.76mm, vary with change in the quantity of Gum Arabic used and also the curing period. For GA-based CSEBs with particle size distribution of fine aggregates between 75µm-600µm, it was observed that at 28 days curing, the optimum percentage of water absorption was reached at 2.74% with Gum Arabic used as partial replacement at 20%. This signifies that any further increase in the content of Gum Arabic will result in a decrease in water absorption. Contrarily, for GA-based CSEBs with particle size distribution of fine aggregates between 1.18mm-4.76mm, it was observed that at 28 days curing period, the rate of water absorption increases at 3.0% with Gum Arabic used as partial replacement at 30%. This signifies that as the content of Gum Arabic increases, so does the rate of water absorption. These values of water absorption for GA-based CSEBs made from different particle size distributions appear to be within the specified value of 12% by the Nigerian Building and Road Research Institute (NBRRI). Furthermore, the findings agreed with Mohammadi and Nokken (2013) which posit that durability can be determined through the rate of water absorption. It can be seen that moisture content influences the rate of water absorption, such that an increase in the moisture content, also increases the water absorption capacity of the CSEBs because the CSEBs have already acquired high moisture content, which potentially creates more pore space to absorb additional water. This shows how the CSEBs interact with water which consequently influence the durability of the bricks.

Conclusion

It can be concluded that, moisture content influences the rate of water absorption, such that an increase in moisture content consequently increases the rate of water absorption. However, the low extent of water permeability

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recorded, reduces the water content in the pores of the CSEBs, thereby reducing the extent of expansion and contraction of the CSEBs, this makes the GA-based CSEBS to be less brittle and more durable.

Recommendations

When selecting eco-friendly bricks for construction of buildings, Gum Arabic based Compressed Stabilised Earth Bricks (GA-based CSEBs), should be utilised considering its low extent of permeability and durability properties for particle size > 600μm.

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Competing interest

The 'Author declares that no competing interest exist'.

Reference

Aguwa, J.I (2010). Performance of Laterite-Cement Blocks as Walling Units in Relation to Sandcrete Blocks. *Leonardo Electronics Journal of Practices and Technologies*.189-200. ISSN: 1583-1078.

Bouzouaid, S., Chaib, H., Kennouche, S.A. (2023). Influence of the addition of Arabic Gum on the Mechanical Properties of Earth Bricks Reinforced by Date Palm Fibres. Conference Colloque International.

British Standard Institution BS 812 (1985). Testing Aggregate. Part 103-Method for Determination of Particle Size Distribution-Section 103. 1 Sieve Test. BSI, London.

British Standard B.S 1881:22: 1983. TESTING Concrete Method for Determination of Water Absorption.

British Standard B.S EN 12620-1. Aggregates for Concrete. Guides on the use of B.S EN 12620.

British Standard 812-109: 1990. Method for Determination of Moisture Content.

Ibrahim, N.A., Magindran, T., Shahrin, M.I., and Yusof, N.M. (2020). Sustainable use of Laterite Soil as Compressed Cement Stabilized Earth b Block for Low Cost Housing Construction. IOP Conf. Series: Materials Science and Engineering 849 (2020) 012027. Doi:10.1088/1757-899X/849/1/012027.

Lelon, J.L., Jumba, I.O., Keter, J.K., Chemuku, W., and Oduor, F.D.O. (2010). Assessment of Physical Properties of Gum Arabic from Acacia Senegal varieties in Baringo District, Kenya. *African Journal of Plant Science*. 4(4). 95-98, ISSN: 1996-0824.

Malkanthi, S.N., Balthazaar, N., and Perera, A.A.D.A.J. (2020). Lime Stabilization for Compressed Stabilized Earth Blocks with Reduced Clay and Silt. Case Studies in Construction Materials,12, e00326.

Mbugua, R., Salim, R., and Ndambuki, J. (2016). Effect of Gum Arabic karrooasa Water-Reducing Admixture in Concrete. Multi-disciplinary Digital Publishing Institute *MDPI Journal*, 9(80)doi: 10.3390/ ma9020080.

EDITOR-IN-CHIEF
Prof. W. F. HILL [MALAWI]

Mohammadi, B, and Nokken, M.R (2013). INFLUENCE OF Moisture Content on Water Absorption in Concrete. Proceedings at the 3rd Specialty Conference on Material Engineering and Applied Mechanics.

Montenegro, M.A., Boiero, M.L., Valle, L., Borsarelli, C.D. (2012). Gum Arabic: More Than an Edible Emulsifier. Products and Applications of Biopolymers. DOI: 10.5772/33783.

Oyelami, C.A., and Van Rooy, J.L., (2016). Are view of the use of Laterite Soil in the Construction/ Development of Sustainable Housing in Africa; A Geological Perspective. *Journal of African Earth Sciences* (119). 226-237. Doi:10.1016/j.jafrearsci.2016.03.018.

Raheem, A.A., Momoh, A.K. and Soyingbe, A.A. (2012). Comparative Analysis of Sandcrete Hollow Blocks and Laterite Inter locking Blocks as Walling Elements. *International Journal of Sustainable Construction Engineering & Technology*, *3*(1).ISSN: 2180-3242.

Razman, R.B., Abdullah, A.H., MdNoh, M.S., and AbdWahid, A.Z. (2010). Thermal and Structural Properties of Compressed Earth Brick (Laterite Soil). Proceedings of the International Postgraduate Conference on Engineering (IPCE2010) 16-17 October 2010, Perlis, Malaysia.

Rimbarngaye, A., Mwero, J.N., and Ronoh, E.K. (2021). Effects of Gum Arabic as Partial Replacement of Cement on the Durability Properties of Compressed Laterite Blocks. *Open Journal of Civil Engineering*, *11*, 398-410. Retrieved:https://doi.org/10.4236/ojce.2021.114023.

Rimbarngaye, A., Mwero, J.N,. and Ronoh, E.K. (2022). Effect of Gum Arabic Content on Maximum Dry Density and Optimum Moisture Content of Laterite Soil. *Heliyon*, *8*(11). Doi:10.1016/j.heliyon.

Riza, M.J., Abdul Rahman, I., and Zaidi, M.A. (2010). A Brief Review of Compressed Stabilized Earth Brick (CSEB), International Conference on Science and Social Research. 999-1004, Doi:10.1109/CSSR.2010.5773936.

Saleh, M.S., and Bala, A.B. (2010). Use of Gum Arabic as Lateritic Soil Stabilizer. *Journal of Sciences and Multi Disciplinary Research*, *2*(1). 48-57.

Satti, S.A.A., and Ahmed, Y.H. (2018). Use of Gum Arabic (Acacia Seyal) as Concrete Admixture. 2nd Conference of Civil Engineering–Dec. 2018.

Tiamiyu, Q.O., Adebayo, S.E., and Yusuf, A.A. (2023). Gum Arabic Edible Coating and its Application in Preservation of Fresh Fruits and Vegetables: A Review. *Journal of Food Chemistry Advances*, 2. Retrieved: https://doi.org/10.1016/j.focha.2023.100251.

United Nations Environment programme (2023). Building Materials and the Climate: Constructing a new future. Retrieved: https://www.unep.org/resources/report/building-materials-and-climate-constructingnew-future.

United Nations (2016). The Sustainable Development Goals Report. Department of Economic and Social Affairs of the United Nations Secretariat. ISSN: 978-92-1-101340-5.

Naturally Grown Acacia Senegal (Linne) Willd trees in the Central Rift Valley of Ethiopia. *Food Hydrocolloids,* 23,175-180.DOI:10.1016/j.foodhyd.2007.12.008

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