

PERFORMANCE ASSESSMENT OF LOCALLY PRODUCED POZZOLANIC CEMENT BLOCKS AS A SUSTAINABLE ALTERNATIVE TO ORDINARY PORTLAND CEMENT SANDCRETE BLOCKS

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Abstract

This study compares the performance properties of Ordinary Portland Cement (OPC) and Pozzomix cement sandcrete blocks, with a focus on sustainable construction practices. The key properties evaluated include compressive strength, water absorption, density, and weight, alongside the critical influence of water-cement ratios. In the experiment, blocks were produced using an inverted mix ratio of 1:16 (cement to sand), and the curing process spanned various time frames to assess the long-term durability of both cement types. Laboratory tests were conducted to measure mechanical properties at 7, 14, 28, and 60 days of curing, while the water absorption rate was tested over 28 days. Results indicate that both materials meet basic performance standards, but Pozzomix blocks showed a higher compressive strength and improved performance in harsh environmental conditions, suggesting greater durability over time. Although OPC sandcrete blocks had a lower water absorption rate, the water-cement ratio in Pozzomix blocks contributed to denser structures, making them more sustainable for load-bearing applications. Pozzomix cement also demonstrated a reduced carbon footprint, as its production involves the use of natural pozzolanic materials, which significantly lowers CO₂ emissions compared to OPC. This analysis emphasizes the potential for Pozzomix to enhance the sustainability of the construction industry, particularly in developing economies like Ghana, where affordable and eco-friendly building materials are needed. The findings suggest broader global applications for Pozzomix cement in reducing the environmental impact of construction while ensuring structural integrity in diverse climates.

Keywords: Ordinary Portland Cement (OPC), Pozzomix Cement, Economically, Eco-efficiently Sustainable, and Commercialisation.

INTRODUCTION

Sustainable construction has become a global priority due to the increasing need for eco-friendly building materials that reduce environmental degradation. The National Housing Policy (NHP) of Ghana mandates the use of locally sourced and produced building materials in construction, aiming to boost the use of sustainable resources in the industry (Len et al., 2024; Andoh, 2015). In recent years, there has been growing global awareness of the need to minimize the carbon footprint of construction materials. One of the major contributors to global CO₂ emissions is the production of Ordinary Portland Cement (OPC) which accounts for about

8% of the world's carbon dioxide emissions (Andrews, 2018). This has motivated researchers and industry stakeholders to explore more sustainable alternatives, such as pozzolanic materials, which have a much lower environmental impact (Bediako & Valentini, 2022). By incorporating such materials, the construction industry can play a crucial role in reducing the environmental burden caused by the increasing demand for infrastructure development and urbanization (Sarfo-Ansah et al., 2014). Ghana, like many developing countries, has seen a rapid increase in cement consumption, driven by population growth and the need for more housing and infrastructure. This rising demand, combined with currency fluctuations and rising fuel costs, has led to a significant increase in the price of cement, which in turn affects the affordability of housing (Ghana Statistical Service, 2022). The Ghana Statistical Service reports in the same year identified the use of sandcrete blocks for building outer walls has risen steadily over the past two decades, from 39.1% in 2000 to 64.1% in 2021. According to Adebajo et al., (2024) these blocks, made from cement, sand, and water, are widely used due to their relatively high compressive strength and affordability. However, their performance can be inconsistent, largely due to variations in production methods, binder costs, curing duration, block sizes, and the properties of the constituent materials (Awolusi et al., 2021). Despite the widespread use of sandcrete blocks, challenges remain in ensuring the consistency and quality of the blocks produced, particularly with regard to their compressive strength and durability. The production process, including factors like mixing ratios and moulding methods, plays a critical role in determining the overall strength and performance of the blocks (Ozoani & Onwudiwe, 2023). Poor construction practices and limited quality control further worsen these issues, leading to substandard structures that can ultimately fail to meet national and international building standards (Boateng, 2020). In response to these challenges, there has been increasing interest in the use of pozzomix cement, a locally produced pozzolanic material, as an alternative to OPC (Al-Shugaa et al., 2024). Pozzolanic materials, which are derived from natural sources like calcined clay, can significantly reduce the environmental impact of construction, while also providing a cost-effective alternative to OPC. This study seeks to explore the performance of Pozzomix cement compared to OPC in the production of sandcrete blocks, with the aim of promoting more sustainable construction practices in Ghana and beyond.

National Development and Pozzolana Industry in Ghana

The cement industry in Ghana faces significant challenges and opportunities, particularly with the growing recognition of pozzolanic cement as a sustainable alternative to Ordinary Portland Cement (OPC). Pozzomix, a locally produced pozzolanic cement, has emerged as a viable solution to the economic, technical, and environmental hurdles posed by OPC. Globally, pozzolanic materials, such as those in Pozzomix, are gaining traction, especially in regions like Latin America, Southeast Asia, and parts of Africa, due to their ability to reduce both production costs and greenhouse gas emissions (Marey et al., 2024; Schmidt & Olonade, 2022). Research from countries such as India and Brazil (Ozturk et al., 2022; Stafford et al., 2016) suggests that incorporating pozzolanic materials in concrete can reduce cement consumption by up to 40%, translating into substantial cost savings and a lower environmental footprint. In Ghana, the construction industry is a major economic driver, contributing 12.8 billion Ghanaian

cedis (approximately 2.1 billion U.S. dollars) to the Gross Domestic Product (GDP) in 2020 (Sasu, 2021). The country also faces a critical housing shortage, with a deficit exceeding 2 million units as of 2023 (Ministry of Works and Housing, 2024; Opoku et al., 2024). However, the rising cost of OPC, fueled by inflation, currency devaluation, and increasing fuel prices, has created a significant barrier to affordable housing. The price of OPC in Ghana has surged by over 500% in the past decade (Ghana Statistical Service, 2022). This makes the use of Pozzomix, derived from locally available clay pozzolana, a cost-effective alternative. By reducing reliance on imported cement, Pozzomix helps lower costs while also offering technical benefits such as enhanced long-term strength, reduced thermal expansion, and improved resistance to chemical attacks, which are particularly important in tropical climates like Ghana's (Bansal et al., 2024). In addition to its economic and technical advantages, Pozzomix offers significant environmental benefits. OPC production is a major contributor to global CO₂ emissions, accounting for approximately 8% of the total emissions worldwide (Purton, 2024). By replacing a significant portion of OPC with Pozzomix, Ghana's construction industry can lower its carbon footprint and align with global efforts to combat climate change (Sizirici et al., 2021). Research by CSIR-BRRI in Ghana has shown that calcined (burnt) clay, a key component of Pozzomix, can replace up to 40% of OPC in construction, which could greatly reduce production costs and emissions. Pozzomix cement also addresses the issue of poor-quality sandcrete blocks, commonly used in partition and load-bearing walls in Sub-Saharan Africa. These blocks often fail to meet international standards, but Pozzomix offers a solution by improving the quality, reducing shrinkage, minimizing chemical attacks, and preventing the leaching of harmful compounds.

This makes it a key component in promoting sustainable construction in Ghana, enhancing the durability and comfort of housing, and aligning with the nation's sustainable development goals. As Ghana seeks to balance rapid urbanization with environmental sustainability, the adoption of Pozzomix in the construction industry reflects a global shift toward more eco-friendly building materials. With its potential to reduce costs, improve building quality, and lower emissions, Pozzomix represents a critical tool in addressing both the economic and environmental challenges facing Ghana's construction sector.

METHODS AND MATERIALS

Research design

This study adopts a mixed-method approach, combining both qualitative and quantitative research methods. Surveys were conducted with building contractors and research scientists to collect qualitative insights into the use of Ordinary Portland Cement (OPC) and Pozzomix cement in construction. Simultaneously, experimental research was undertaken to quantitatively assess the mechanical and physical properties of sandcrete blocks, including compressive strength, density, and water absorption. The qualitative aspect gathers perspectives from building contractors and research scientists through surveys, providing contextual and practical understanding of OPC and Pozzomix cement. The quantitative component focuses on experimental testing to measure key physical and mechanical properties,

ensuring objective data analysis. Together, these methods offer a well-rounded approach, blending practical insights with precise, data-driven results that can be applied globally. These properties were tested using internationally recognized standards, such as ASTM C109 for compressive strength and ASTM C642 for water absorption, ensuring that the results are comparable to global benchmarks. This methodological approach not only addresses local Ghanaian challenges but also extends the relevance of the findings to other regions employing similar construction practices.

Population

The population of the study comprised building contractors working in the Kumasi Metropolis and its surrounding areas, along with research scientists from the Centre for Scientific and Industrial Research - Building and Road Research Institute (CSIR-BRRI). This population was selected to ensure a comprehensive understanding of both field applications and scientific insights into the use of Pozzomix and OPC in block production.

Sampling Technique and Sample Size

A purposive sampling technique was used to target individuals with relevant experience. A total of 35 building contractors and 11 research scientists working on Pozzomix and OPC were sampled. For the experimental portion, 25 blocks of Pozzomix cement and 25 blocks of OPC, making up a total of 50 blocks, were produced for laboratory testing. These blocks were sourced from various construction sites to capture a diverse range of production practices.

Data Collection Techniques and Instruments

Data were gathered using a combination of structured questionnaires (both open- and close-ended), observations, and laboratory experiments. Additionally, literature reviews and documentary analyses of standards were conducted to provide context for the experimental findings. The combination of these methods allowed for robust data collection that could address both the qualitative perceptions and quantitative measurements of block performance.

Materials for the Manufacture of Sandcrete Blocks

Ordinary Portland Cement (OPC)

The Ordinary Portland Cement used for this study was sourced from Ghana Cement (GHACEM), classified as 32.5R, and conforming to the international specifications of ASTM and British Standards.

Pozzomix Cement

Pozzomix cement of class 32.5R, manufactured by CSIR-BRRI, was used in the production of sandcrete blocks. This cement conforms to both Ghana Standard and International Standards, ensuring its relevance for broader global applications.

Pit Sand

The pit sand used in the mortar mix was obtained from local suppliers. Physical assessments indicated that the sand did not fully satisfy the international British Standards (BS) part 6

requirements, highlighting potential quality control issues that may affect block performance.

Water

The water used in the block production was potable, clean, and free from contaminants, as per the Ghana Standard (GS) specifications. The use of clean water is critical for maintaining the integrity and durability of sandcrete blocks in construction.

Manufacturing process for Pozzomix and OPC sandcrete blocks

The block manufacturing process was closely monitored to ensure standardization. The site was cleared of any debris, and a single-chamber manual block moulding machine was used for the moulding process. Manual mixing of the cement and sand was performed on-site using shovels, and water was added randomly based on visual assessment. The semi-dry mortar was placed into the moulding machine and pressed into shape. Curing of the blocks involved sprinkling water for three consecutive days, with the blocks left to air dry. After 7 days, the blocks were transported to the laboratory for testing.

Measurement of Dimensions and Weights

The dimensions and weights of each block were measured before proceeding with density and strength testing.

Determination of Density

The density of the blocks was calculated using the following formula:

$$\text{DENSITY} = \frac{\text{MASS}}{\text{VOLUME}} (\text{kg/mm}^3)$$

This method aligns with the international standards for determining the density of concrete and masonry blocks.

Determination of Compressive Strength

The compressive strength of the blocks was measured using the Automatic Tensile and Compressive Strength Testing Machine at curing intervals of 7, 14, 28, and 60 days. The compressive strength was calculated using the formula:

$$R = \frac{F}{A}$$

where **R** is the compressive strength in MPa, **F** is the maximum load at fracture (in KN), and **A** is the area of the block (in mm²). These results were compared against **ASTM C109** standards for global comparability.

Determination of Water Absorption

Water absorption was tested using **ASTM C642**, and the formula:

$$W = \frac{M_2 - M_1}{M_1} \times 100$$

where **M1** is the dry weight (before oven drying) and **M2** is the wet weight (after absorption). This test was conducted to measure the porosity and potential durability of the blocks, important indicators for structural integrity in varying climatic conditions.

RESULTS AND DISCUSSION

The results were presented based on observation, questionnaire and experiment.

Observation

Observations were conducted at various construction sites, accompanied by photographs documenting the conditions of the structures. The assessment revealed inconsistencies in the performance of existing buildings; some constructed with Pozzomix cement exhibited no visible defects, while others showed signs of cracking and deterioration. In contrast, structures built with Ordinary Portland Cement (OPC) displayed significant issues, including cracks and peeling paint. These observations highlight the varying performance characteristics of the two cement types under similar environmental conditions.



Figure 1: Pozzomix cement sandcrete blocks office complex for ECG-Kumasi, BRRI-CSIR Centre gate-Fumesua



Figure 2: OPC sandcrete blocks for Classroom block

Questionnaire

The questionnaire administered to contractors and research scientists began by gathering general demographic information about the respondents. It then assessed the physical properties and performance of sandcrete blocks made from Pozzomix and Ordinary Portland Cement (OPC).

The responses indicated that Pozzomix cement blocks demonstrated higher compressive strength, reduced moisture movement, and lower thermal expansion compared to those made with OPC. Conversely, OPC sandcrete blocks exhibited lower shrinkage and greater standard consistency than their Pozzomix counterparts.

Table 1: Properties of Sandcrete block from OPC and pozzomix

Properties	N	OPC			Pozzomix		
		Actual Response	Mean	Std. Dev.	Actual Response	Mean	Std. Dev.
High compressive strength	30	8	3.80	1.215	8	3.97	1.066
Low shrinkage	30	8	3.83	1.085	8	3.43	1.104
Low moisture movement	30	8	3.80	.997	7	4.33	.661
Low thermal movement	30	13	2.17	1.642	12	2.93	1.721
Denseness and durability	30	7	4.27	.785	7	4.27	.785
Standard consistency	30	7	4.43	.679	7	4.37	.809

Source: Researcher Field Work, 2018, Mean > 3.0=agreed

The respondents indicated that Ordinary Portland Cement (OPC) is characterized by high compressive strength, low shrinkage, minimal moisture movement, low thermal expansion, density, durability, and standard consistency.

In comparison, Pozzomix cement exhibited higher compressive strength and reduced moisture movement, though it had lower shrinkage and standard consistency than OPC. Key factors influencing the strength characteristics of cement include fineness and chemical composition.

Table 2: Satisfaction Level of Contractors on OPC and Pozzomix Cement

Satisfaction Level	N	OPC			Pozzomix		
		Actual Response	Mean	Std. Dev.	Actual Response	Mean	Std. Dev.
Availability	30	7	4.33	.884	7	4.23	.898
Suitability	30	7	4.20	1.031	7	4.07	1.081
Weather resistivity	30	7	4.37	.765	7	4.10	1.094
Workability	30	8	3.83	1.177	7	4.10	1.094
Dampness resistance	30	7	4.37	.809	7	4.03	1.066

Source: Researcher Field Work, 2018, Mean > 3.0=satisfied

The study results indicated that contractors were highly satisfied with the durability of Pozzomix cement compared to Ordinary Portland Cement (OPC). Additionally, they reported similar satisfaction regarding the workability of both cements, with a mean score of 4.10 and a standard deviation of 1.094.

The contractors concurred with Botchway & Masoperh (2019), who noted that Pozzomix cement has a higher fineness than OPC, resulting in lower permeability and enhanced durability, leading to longer-lasting structures.

Furthermore, Mohsen et al., (2023) confirmed that Pozzomix cement is environmentally friendly, utilizing non-toxic, locally available materials and by-products from coal-fired industries.

Table 3: Performance of the OPC and Pozzomix cement sandcrete blocks

Performance	N	OPC			Pozzomix		
		Actual response	Mean	Std Dev.	Actual response	Mean	Std Dev.
Good for all construction works	30	8	3.09	1.375	7	4.64	.505
Does not get damaged easily	30	8	3.18	1.471	7	4.82	.405
Easy to hardening	30	8	3.27	1.348	7	4.73	.647
It is good for water logged areas in the country	30	13	2.64	1.362	7	4.91	.302
Has very good technical properties	30	8	3.27	1.272	7	4.36	.505
Its workability is major factor in performance delivery	30	7	4.18	.405	7	4.73	.467

Source: Researcher Field Work, 2018, Mean > 3.0=agreed

The Table summarizes the responses to six statements used to assess the performance of Ordinary Portland Cement (OPC) and Pozzomix sandcrete blocks.

The results indicate that Pozzomix is suitable for various construction applications, demonstrates resilience against damage, performs well in waterlogged areas, and exhibits excellent technical properties. Its workability is also a significant factor in enhancing overall performance.

Additionally, pozzolanic materials offer economic, ecological, and technical advantages for sustainable development, including improved strength, reduced thermal effects, and resistance to chemical attacks. They have minimal environmental impact and contribute positively to climate change mitigation.

Experiment

The results of the experiment conducted to determine the various properties (mechanical and physical properties such as compressive strength, density, weights and water absorption) of sandcrete blocks produced from pozzomix cement and OPC as presented below.

Compressive strength test result of OPC and Pozzomix cement blocks

The compressive strength tests were carried out for 7, 14, 28, and 60 days of sandcrete blocks from OPC and pozzomix cement respectively.

Table 4 presents the average results of the compressive strength test report of the OPC and pozzomix cement sandcrete block specimen.

Table 4: Compressive strength of OPC and Pozzomix sandcrete blocks

	Samples	OPC					Pozzomix				
	Dimension (mm)	Results (N/mm ²)	Mean (N/mm ²)	Std dev.	Std Error mean	Dimensions (mm)	Results (N/mm ²)	Mean (N/mm ²)	Std. dev.	Std. Error mean	Periods of Tests Days
1	455 x 238 x 122	0.038					0.558				
2		0.078					0.130				
3		0.076	0.073	0.0 21	0.009	454 x 230 x 118	0.448	0.319	0.178	0.081	7
4		0.093					0.208				
5		0.078					0.245				
1	428 x 223 x 110	0.134					1.168				
2		0.141					1.126				
3		0.161	0.148	0.0 14	0.006	430 x 223 x 120	1.061	0.94	0.940	0.288	14
4		0.141					0.463				
5		0.166					0.884				
1	428 x 223 x 110	0.395					1.288				
2		0.428					1.236				
3		0.398	0.27	0.1 77	0.078	430 x 223 x 120	1.223	1.129	0.174	0.078	28
4		0.330					0.876				
5		0.271					1.022				
1	425 x 230 x 110	0.431					0.934				
2		0.284					1.551				
3		0.274	0.354	0.1 06	0.048	430 x 230 x 110	1.288	1.275	0.282	0.126	60
4		0.503					1.551				
5		0.279					1.050				

Mix ratio (inverted 1:16) Pozzomix: [t=10.6336, sig. (2-tailed) =0.001]; OPC: [t=11.568, sig. (2-tailed) =0.008]

Source: Researcher Field Work, 2018

From table 4, the compressive strength of both OPC and Pozzomix cement sandcrete blocks was evaluated at different curing stages. While both materials fell short of international standards (BS 2028) 2.8 N/ mm² requirement for compressive strength at early curing ages, Pozzomix cement showed superior performance compared to OPC. Globally, the compressive strength of pozzolanic cement has been found to increase over time, which is consistent with the results of this study (Rahma & Jomaa, 2018). Pozzomix blocks exhibited greater density and lower water absorption, which suggests that they may be more durable in the long term, particularly in humid or waterlogged environments. These findings align with international research (Nilimaa, 2023) on pozzolanic materials, which highlights their potential for sustainable building practices in regions with similar climates.

Weight test result of OPC and Pozzomix cement sandcrete blocks

Presented in Table 5 are the results of the weight of OPC and Pozzomix cement blocks. The weight tests were carried out for 7, 14, 28, and 60 days respectively.

Table 5: Weight test results of OPC and Pozzomix sandcrete blocks

samples	Ordinary Portland cement sandcrete blocks				Pozzomix cement sandcrete blocks				
	Dimension (mm)	Weight (Kg)	Mean	Std dev.	Dimension (mm)	Weight (Kg)	Mean	Std dev.	Periods of tests Days
1	455 x 238 x 122	24.9	24.90	.0000a	454 x 230 x 118	25.5	25.50	.0000a	7
2		24.9				25.5			
3		24.9				25.5			
4		24.9				25.5			
5		24.9				25.5			
1	428 x 223 x 110	24.3	24.38	.1924	430 x 223 x 120	25	25.08	.1304	14
2		24.1				25			
3		24.5				25			
4		24.4				25.1			
5		24.6				25.3			
1	428 x 223 x 110	23.2	23.36	.3050	430 x 223 x 120	24.7	24.40	.3647	28
2		23.3				24.9			
3		23.8				24.4			
4		23.5				24.0			
5		23.0				24.2			
1	425 x 230 x 110	23.2	23.64	.6693	430 x 230 x 110	24.8	24.64	.2408	60
2		23.3				24.7			
3		23.8				24.9			
4		23.5				24.3			
5		23.0				24.5			

(Mix ratio: inverted 1:16 to 1:18/0.6 and cement: sand/w/c)

Source: Researcher Field Work, 2018

The average weight of Ordinary Portland Cement (OPC) sandcrete blocks ranges from 24.90 kg at 7 days to 23.6 kg at 60 days, while the average weight of Pozzomix sandcrete blocks decreases from 25.50 kg at 7 days to 24.64 kg at 60 days. Pozzomix cement sandcrete blocks consistently outperformed OPC blocks in weight across all curing ages; however, they fell short of the expected standards due to factors such as compaction level, the "inverted" mix ratio, and the water-cement ratio utilized by contractors. According to BS EN 771-3 (2003) the nominal

weight of a 200 x 200 x 400 mm sandcrete block made with heavy aggregates ranges from 18.16 kg to 22.7 kg, while blocks made with lightweight aggregates weigh between 25 kg and 35 kg. A study by Ismaila and Aderele (2015) indicated that the average weight of blocks produced by manufacturers is 17.9 kg for 6-inch blocks and 22.76 kg for 9-inch blocks, both exceeding the Safe Weight of Lift (SWL). The mean Load Strain Susceptibility Index (LSSI) values were reported at 1.48 (± 0.26) for safe conditions and 3.94 (± 0.52) for hazardous conditions. Therefore, understanding the safe weight of sandcrete blocks is crucial for minimizing dead weight and ensuring structural integrity.

Density test result of OPC and Pozzomix cement blocks

Density tests for Ordinary Portland Cement (OPC) and Pozzomix cement blocks were conducted at intervals of 7, 14, 28, and 60 days. The average density of Pozzomix cement blocks was greater than that of OPC after 7 days, while OPC recorded an average density of 2180.6 kg/m³ at 14 days. The density of OPC increased further at 28 and 60 days, ultimately achieving the highest densities in the study, with a minimum density of 1884.7 kg/m³ observed. The recommended minimum density of 1500 kg/m³ for first-grade or load-bearing sandcrete blocks, as suggested by International Standard Industrial Classification (ISIC) and (Adebanjo et al., 2024), was higher than the densities reported in previous research. These higher density values can be attributed to variations in the mix ratio and the degree and quality of compaction achieved during block production. According to Karthik et al., (2017), sandcrete blocks made from OPC typically have densities ranging from 1920 to 2080 kg/m³, while lightweight sandcrete blocks are often prioritized for their reduced density rather than strength.

Water absorption of OPC and Pozzomix cement blocks

The water absorption test was done for 28 days curing age. Table 6 presents the average results of water absorption of sandcrete blocks produced from OPC and pozzomix cement.

Table 6: Water absorption of OPC and pozzomix cement sandcrete blocks

Category	Results (%)	Mean	Std. Dev.	Std. Error Mean	T	Sig. (2-Tailed)	95% Confidence Interval of The Difference	
							Lower	Upper
Water absorption of OPC sandcrete blocks	11.57							
	9.99							
	10.97	10.960	1.246	.55724	19.66	.000	9.413	12.507
	9.58							
	12.69							
Water absorption of Pozzomix cement sandcrete blocks	10.97							
	12.76							
	12.83	11.04 2	2.760	1.2343 5	8.95	.00	7.615	14.469
	6.29							
	12.36							

Source: Researcher Field Work, 2018

The water absorption results in Table 6 show that OPC sandcrete blocks absorbed less water (10.96%) compared to Pozzomix cement blocks (11.04%). Water within the pores of masonry units can expand and contract, creating internal stresses that weaken the material over time. As reported by Shahreza et al., (2021), masonry units with lower water absorption limit the amount of water that could lead to deterioration. This suggests that Pozzomix blocks, with higher water absorption, are more porous than OPC blocks. As Binici et al., (2019) noted, water absorption is determined by the decrease in mass of a dry sample, which affects the bond between aggregates and cement, as well as the resistance of concrete to freezing, thawing, chemical attack, and abrasion. Good quality concrete has minimal voids caused by excess water, which is why water absorption testing is critical for assessing the density and impermeability of concrete as agreed by (Jahandari et al., 2023).

For OPC sandcrete blocks, the 95% confidence interval for water absorption ranged from 9.4% to 12.5%, while for Pozzomix blocks, it ranged from 7.6% to 14.5%. The study found a positive correlation between water absorption and block performance, with OPC showing a significant relationship ($t=19.66$, $p=0.000$) and Pozzomix also showing a positive trend ($t=8.95$, $p=0.001$). Both types of blocks fell within the acceptable water absorption range of 11% to 16%, which positively affects durability. However, Hammat et al., (2021) argued that pozzolanic materials typically absorb less water than OPC, as higher pozzolana content reduces absorption. Studies by Becerra-Duitama & Rojas-Avellaneda, (2022), Awoyera & Adesina, (2020) and Mastali et al., (2018) supported this, finding that pozzolanic blocks generally absorb less water and offer greater resistance to acid attack. In this study, the high permeability observed in Pozzomix blocks is linked to their lower density, as noted by Okafor and Egbe (2017).

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

Summary of the Findings

The performance of Pozzomix cement and OPC sandcrete blocks in existing structures revealed inconsistencies, with cracks and defects observed, largely due to non-compliance with proper manufacturing processes. Both materials demonstrated weights and densities above the GS 297 (2011) minimum specifications, making them suitable for both load-bearing and non-load-bearing structures. However, neither material met the required minimum compressive strength, potentially affecting the durability and performance of the blocks. The water absorption tests indicated that Pozzomix blocks absorbed more water than OPC blocks, though both fell within the acceptable range of 11% to 16%, suggesting that lower water absorption correlates with higher strength and durability, as it reduces the risk of deterioration.

Conclusion

The strength and consistency of sandcrete blocks in Ghana remain challenged by factors such as the high cost of cement, inconsistent production methods, curing times, and material properties. Pozzomix cement presents a viable alternative to OPC, offering superior compressive strength and density at various curing stages, and comes at a more affordable price. A 50 kg bag 32.5R of Pozzomix costs GHC90.00, compared to GHC100.00 for OPC,

representing a price difference of 10-14%. This cost advantage highlights Pozzomix as a more economical choice for construction, contributing to reduced building costs in Ghana and aligning with global efforts toward sustainable construction solutions.

Recommendations

For sustainable development in Ghana, greater reliance on locally available construction materials like Pozzomix cement, with its high-performance properties, should be encouraged. To improve the properties of OPC sandcrete blocks, strict adherence to proper manufacturing processes—including batching, mixing, compacting, curing, and maintaining the correct water-cement ratio—must be enforced under the supervision of regulatory authorities. Ensuring the compressive strength meets minimum standards is crucial, as failure in this regard compromises structural integrity. Regular monitoring should be conducted to prevent excessive water absorption, which affects block durability. Pozzolan materials like Pozzomix are key to producing sustainable concrete products globally, offering a model for reducing environmental impacts in construction.

Suggestions for Future Research

Future research could explore comparative cost analysis between OPC and Pozzomix cement for construction on a global scale, focusing on their economic viability and sustainability benefits. Given that the study's experiments were conducted on sandcrete blocks produced in the field with potential deviations from the correct mix ratio, future studies should utilize the control mix ratio (1:6) in a laboratory setting to achieve more precise comparisons. Research should also investigate the compliance of sandcrete block manufacturers with international specifications and standards, particularly in developing countries like Ghana. Exploring the causes of structural collapse linked to substandard block production and investigating the quality of materials produced by informal contractors and suppliers is essential. Further research could assess the determinants influencing cement selection for sandcrete blocks, comparing field and laboratory-produced blocks, and analyzing the availability and market potential of Pozzomix cement within the broader African and global markets.

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