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Research Article

INFLUENCE OF CURING MEDIA ON THE COMPRESSIVE STRENGTH DEVELOPMENT AND ABSORPTION RATE OF LATERIZED CONCRETE

Mark Omeiza ONIPE[1,*], Florence Ngozi NWODI[2], Charles Chukwudifu CHIME [3]

[1]Department of Building, Delta State University of Science and Technology, Ozoro, 334111, Nigeria
[2]Department of Architecture, Delta State University of Science and Technology, Ozoro, 334111, Nigeria
[3]Department of Architecture, Delta State University of Science and Technology, Ozoro, 334111, Nigeria

[*]Correspondence: onipemo@dsust.edu.ng

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ORCID[a]: 0009-0001-3267-2026, ORCID[b]: 0009-0006-1422-9668, ORCID[c]: 0000-0002-1880-1231

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Abstract

The study investigates the impact of different curing techniques on the compressive strength and absorption rate of laterized concrete, a sustainable material integrating laterite as a partial or full substitute for conventional sand. Over curing durations spanning 1 to 28 days, compressive strength and sorptivity of laterized concrete specimens were evaluated under varied curing conditions: water immersion, intermittent sprinkling, wet rug covering, plastic sheet covering, and air-drying. Results indicate a consistent trend: higher laterite content correlates with decreased compressive strength yet increased sorptivity. Notably, water immersion consistently yielded the highest compressive strength (31.68 N/mm²) and lowest sorptivity (0.0201 mm/√s) after 28 days, followed by the order of intermittent sprinkling, wet rug, plastic sheet coverings, and air-drying, with the air-drying exhibiting the poorest performance. The study underscores the pivotal role of curing methods, revealing an inverse relationship between compressive strength and sorptivity. Moreover, as the curing duration extends, compressive strength improves while sorptivity diminishes, emphasising the enduring efficacy of curing. These insights accentuate the significance of selecting suitable curing strategies to enhance laterized concrete structures' performance and durability, thereby advancing sustainable construction practices.

Keywords: Laterised concrete, curing method, compressive strength, sorptivity, Sustainability

1. INTRODUCTION

Concrete, a core structural material, can be modified or adjusted to enhance its performance and sustainability; this adaptability has resulted in the study of diverse formulations. A particular modification is the incorporation of laterite, either partially or wholly replacing sand, giving rise to a type of concrete called laterized concrete. This inventiveness offers an environmentally friendly alternative for construction, especially in regions where laterite is readily available. By minimising the need to transport materials over long distances, it helps reduce the associated carbon footprint (Folagbade, 2020). Beyond its environmental advantages, the inclusion of laterite in concrete also enhances its mechanical performance and durability.

Investigations into the viability of replacing traditional sand with laterite as fine aggregate in structural concrete revealed that the compressive strength of laterized concrete decreases with increasing laterite content. Nevertheless, the studies recommend replacement levels of laterite within 50% for use in construction (Awolusi et al., 2017, 2021; Garba et al., 2024; Udeme et al., 2022), depending on the concrete mix ratio and the laterite constituent.
Concrete's compressive strength is a fundamental indicator of its structural integrity and load-bearing capacity (Gogineni et al., 2024; Kumar & Pratap, 2024; Li et al., 2020; Pan et al., 2024). It serves as a critical parameter in determining the suitability of concrete for various construction applications. Understanding the factors that influence compressive strength development is essential for optimising concrete mixtures and ensuring the longevity of constructed structures.

In addition to compressive strength, the absorption rate of concrete remains a key consideration in assessing its durability and resistance to environmental degradation (Awolusi et al., 2021; Balakrishna et al., 2020; Moore et al., 2021). In the realm of the durability of laterized concrete, Onipe & Folagbade (2017) explore the absorption rate of laterized concrete by determining the sorptivity values of the concrete at varying mix ratios, curing ages, and laterite contents. The results indicate that higher curing age and richer mix reduce sorptivity values while higher laterite contents increase sorptivity values.

The absorption rate of concrete is crucial in defining its performance, largely in adverse external conditions (Rucker-Gramm & Beddoe, 2010; Zhuang et al., 2022). Comprehending the rate of absorption helps in assessing the susceptivity of concrete to environmental factors including freeze-thaw cycles, chemical attacks, and other deteriorating agents (Abdurahman et al., 1996; Mehta & Monteiro, 2014; Zhang & Zong, 2014; Du et al., 2016; Yang et al., 2021). The ability of concrete to resist the ingress of water is paramount for durability, as increased water absorption can lead to degradation mechanisms such as freeze-thaw cycles, chemical attacks, and corrosion of reinforcement (Abdurahman et al., 1996; Mehta & Monteiro, 2014; Zhang & Zong, 2014).

Sorptivity stands as a crucial technique in assessing concrete absorption, delineating the propensity of porous materials to absorb and convey water through capillary processes (Hall, 1989). It has been acknowledged as a significant indicator of concrete durability, offering insights into permeability, microstructure, and resistance to water absorption (Tanyildizi, 2022; Zhang & Zong, 2014). Sorptivity is deemed a crucial element in assessing concrete durability, as it signifies the capillary rise and moisture transport within unsaturated concrete samples (Rehman et al., 2020; Wang & Li, 2014). Moreover, the utilisation of straightforward parameters like sorptivity is increasingly prevalent in assessing the resilience of concrete when subjected to harsh environmental conditions (Akinkurolere, 2021). Reduced sorptivity values signify enhanced concrete resistance to water absorption, underscoring its significance in evaluating concrete durability (Rachel, 2019).

Sorptivity plays a pivotal role in the quality control of construction materials, and its continuous monitoring is essential for guaranteeing the enduring durability and optimal performance of structures (Alexander et al., 2008; Maroliya, 2012; Moore et al., 2021). Furthermore, sorptivity values, when monitored over time, can provide valuable information about the stress level, development, and progression of cracks and damage within concrete (Zhou, 2023).
Curing in concrete is vital for boosting its mechanical strength, durability, and resistance to diverse environmental factors. Effective curing methods play a crucial role in minimizing shrinkage, increasing compressive strength, and enhancing the overall performance of concrete structures (Chand et al., 2015; Federowicz et al., 2020; Gabriel-Wettey et al., 2021; Spijkerman et al., 2022). Studying the impact of different curing media on concrete properties is essential for comprehending the behaviour and performance of concrete under various conditions. Numerous research studies have underscored the importance of curing techniques in influencing the mechanical properties, durability, and other traits of concrete (Abdel-Hay, 2017; Atiş et al., 2005; Federowicz et al., 2020; Kim et al., 2019; Wedatalla et al., 2019).

Therefore, this study aims to investigate the influence of curing media on the absorption rate of laterized concrete and its effect on compressive strength development. By comprehensively analysing these two key properties, this research seeks to provide a holistic understanding of the behaviour of laterized concrete under varying curing conditions. Such insights are essential for optimising construction practices, enhancing the sustainability of infrastructure projects, and promoting the widespread adoption of laterized concrete as a viable construction material in diverse environmental settings.

2. MATERIALS AND METHODS

The materials used in the experiment included Portland cement (PC, 42.5N type) that adhered to BS EN 197-1(2011), along with fine and coarse aggregates at a mix ratio of 1:1½:3, incorporating a water-cement ratio of 0.5. The fine aggregates comprised a combination of sand and laterite, with laterite replacing sand in increments of 10% from 0% to 50%.

The coarse aggregates consisted of angular-shaped granite chippings. Table 1 displays the properties of the aggregates, while Figure 1 illustrates the grading curves of the aggregates. Potable water, meeting BS EN 1008 (2002) was employed for the mixing of the concrete specimens.

Table 1. Characteristics of Aggregates

Properties	**Soil type**		
	Laterite	**Sand**	**Granite**
Fineness modulus	2.85	3.01	6.99
Coefficient of uniformity	3.20	4.88	1.55
Coefficient of curvature	0.94	0.92	0.94
Specific gravity	2.51	2.66	2.72
Moisture content (%)	9.20	1.11	1.61
Liquid limit (%)	25.0	-	-
Plastic limit (%)	14.0	-	-
Plasticity index (%)	11.0	-	-

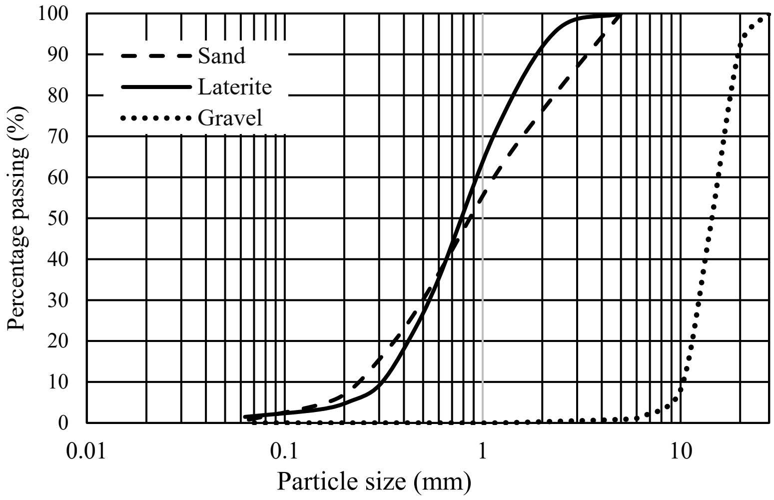


Figure 1. Gradation curves of the aggregates

The concrete specimens, prepared according to BS EN 12390-2 (2009), were cast and initially cured under a layer of polythene sheet for approximately 24 hours before being demoulded. Subsequently, they underwent various curing methods, including curing periods of 1, 3, 7, 14, 21, and 28 days, to ensure a comprehensive assessment of their absorption rates under different conditions.

Firstly, some of the specimens underwent complete immersion in water, maintaining this submerged state throughout the predetermined curing periods. Regular replenishment of water was conducted to uphold a consistent curing environment. Additionally, some specimens were placed in a dedicated curing chamber and subjected to intermittent sprinkling. These specimens were periodically sprayed with water, mimicking natural conditions where moisture is intermittently present, thus maintaining a moist environment conducive to curing. Another set of specimens were shielded with wet rugs to impede moisture evaporation. These rugs remained damp throughout the curing periods, ensuring a sustained level of humidity around the specimens. Moreover, certain specimens were covered with plastic sheets to prevent moisture loss. This method created a sealed environment around the specimens, facilitating controlled moisture exchange. Lastly, a subset of specimens was left to cure in ambient air conditions without additional moisture or covering, serving as a control group to gauge the natural drying behaviour of the concrete without external interventions.

Examinations were conducted for each experimental condition, encompassing various replacement levels of laterite, distinct curing methods, and different curing ages, to determine both the compressive strength and sorptivity of the cubes.

The compressive strength test was performed using the precision of a compression testing machine, the ELE 2000 kN. Under controlled conditions, the specimens were systematically loaded until they failed. The maximum load sustained by each specimen before failure allowed for the calculation of its compressive strength.

The sorptivity test, following ASTM C1585 (2013) began with smoothing the specimen's two end surfaces with an iron brush for easier water absorption and air release. After oven drying and cooling, the side surface was waxed, while the end surface that would not be exposed to water was covered with a loosely attached plastic sheet, allowing air to escape without water loss. The initial mass was recorded, and the specimen was placed in tap water for testing, as shown in Figure 2.

Figure 2. The sorptivity test system

Mass was recorded at specific intervals, starting at 60 seconds and extending up to 6 hours. Absorption (I) was calculated using equation 1, and sorptivity, determined by the slope of absorption plotted against the square root of time (√s), was obtained through linear regression analysis. The average of three test results for an experimental condition provided the sorptivity value.

$$I = \frac{m_t}{a \times d} \tag{1}$$

Where:
I: cumulative specimen absorption in mm,
m_t: cumulative change in the specimen mass in grams, at time *t,*
a: area of the specimen exposed to water absorption in mm^2, and
d: density of water in g/mm^3.

3. RESULTS AND DISCUSSION

The compressive strength values of the laterized concrete specimens varied with the laterite content and curing durations. Generally, an increase in laterite content led to a decrease in compressive strength across all curing methods and durations. For example, Figure 3 shows the 28-day compressive strength of the concrete with varying laterite content under water immersion conditions; it indicates a decreasing trend in compressive strength as the laterite content in the concrete increases. This result corresponds with what has been found in previous studies (Onipe & Folagbade, 2017; Ambrose et al., 2018; Oni & Arum, 2023; Ukpata et al., 2024). With no laterite content (0%), the compressive strength is highest at 31.68 N/mm^2, and it gradually decreases with each increment of laterite content. The decrease in compressive strength with higher laterite content may stem from the less effective bonding of laterite particles with other components, leading to weaker interfacial transition zones within the concrete.

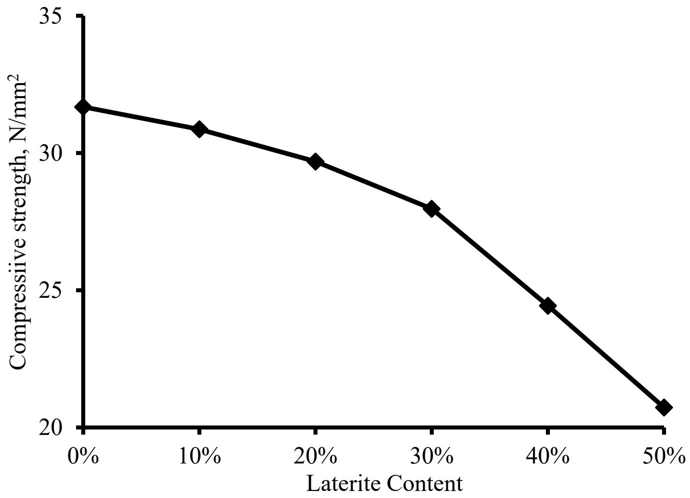
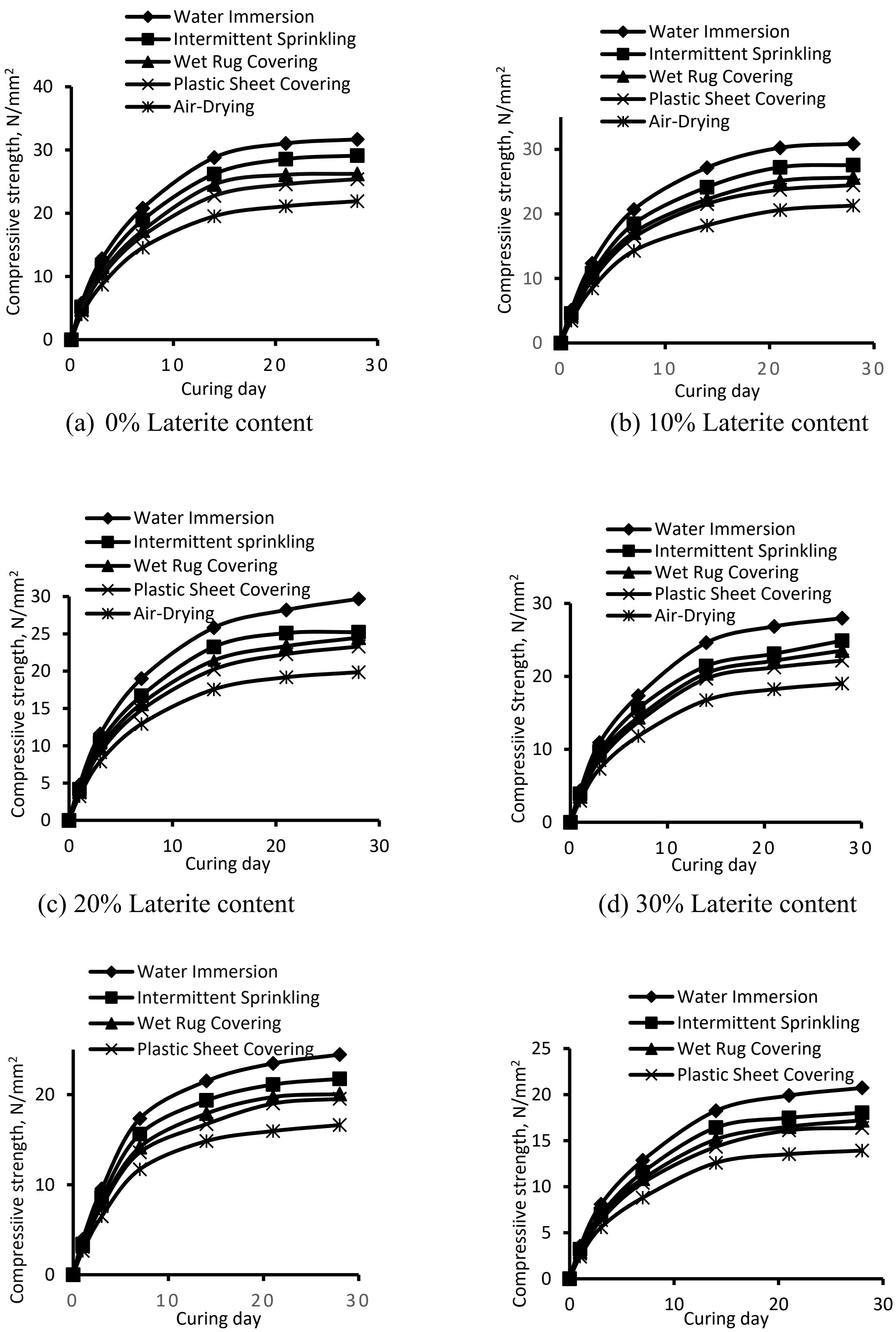


Figure 3. 28-day Compressive strength variation of concrete with varying laterite content in water immersion condition

The rate at which compressive strength decreases demonstrate a consistent trend as laterite content increases in the concrete mix. There is a moderate decline of approximately 2.56% at 10% laterite replacement. However, this decline becomes more pronounced with higher levels of laterite content. At 20% replacement, the decrease accelerates to around 6.29%, indicating a more substantial impact on compressive strength. This trend continues with even greater intensity at 30%, 40%, and 50% laterite replacement, where the decrease in strength reach approximately 11.73%, 22.88%, and 34.53% respectively. These findings suggest a nonlinear relationship between laterite content and compressive strength, with higher levels of replacement exerting increasingly significant reductions in strength.

The curing age and method also significantly influenced the compressive strength of the laterized concrete specimens. In general, compressive strength tends to increase with curing age regardless of the curing method and laterite content. This is evident in Figure 4, where the compressive strength values generally rise from the earlier curing ages (d1, d3) to the later curing ages (d21, d28). This increase in compressive strength aligns with the works of Aluko *et al.* (2020), Awoyera *et al.* (2018) and Kamaruzaman & Muthusamy (2013). It can be attributed to the continued hydration of cementitious materials within the concrete matrix over time.

The rate of change of the compressive strength with curing age generally follows a decreasing trend over time across all curing methods and laterized replacement levels. In the initial stages of curing, the rate of increase in compressive strength tends to be relatively high as the hydration process is most active during this period. However, as curing progresses beyond this initial phase, the rate of increase gradually diminishes.



(a) 0% Laterite content

(b) 10% Laterite content

(c) 20% Laterite content

(d) 30% Laterite content

(e) 40% Laterite content

(f) 50% Laterite content

Figure 4. Compressive strength variation of concrete (encompassing varying laterite replacement levels) with different curing conditions and ages

Citing the rate of change of the compressive strength of concrete with 20% laterite content cured under intermittent sprinkling as an example: initially, within the first three days, there is a significant increase in strength, indicating rapid hydration and early strength gain with a remarkable percentage increase of approximately 150.48%. Subsequently, between day 3 and day 7, although the rate of strength gains decreased compared to the initial period, the concrete continues to develop strength at a relatively brisk pace with a percentage increase of approximately 59.47%. By day 14, the rate of strength gain further diminishes as the concrete matures, but significant progress is still evident over the two weeks with a percentage increase of approximately 39.22%.

As the curing process progresses, the rate of strength gain slows down significantly. By day 21, there is a smaller percentage increase of approximately 7.96% compared to earlier intervals, indicating that the concrete is approaching maturity. Finally, during the last week of curing, there is a minimal increase in strength, suggesting that the concrete is nearing its maximum strength and the curing process is nearing completion with a percentage increase of approximately 0.56%. Overall, consistent curing, whether through immersion, intermittent sprinkling, or covering, facilitates the gradual development of compressive strength over time, with higher values typically observed at later curing ages.

It is also evident in Figure 4 that at each laterite replacement level, the compressive strength of the concrete varies with the curing method used. At most time points, water immersion shows higher compressive strength compared to intermittent sprinkling. This could be because water immersion ensures continuous hydration of the material, allowing for more uniform curing and better development of strength compared to intermittent sprinkling, where the surface might dry out between watering sessions. The highest compressive strength observed during water immersion aligns with the findings on both normal and alternative concrete, as presented in Odeyemi *et al*. (2021) and Osei *et al*. (2020).

Intermittent sprinkling generally exhibits higher compressive strength compared to wet rug covering. This might be because intermittent sprinkling maintains a more consistent moisture level over time compared to wet rug covering, where the moisture level could vary based on factors like rug saturation and evaporation.

Wet rug covering exhibits slightly higher strength than plastic sheet covering. This might be because the wet rug covering provides a more localised moist environment around the sample, aiding better hydration.

Plastic sheet covering consistently demonstrates higher compressive strength compared to air drying. This is likely because plastic sheet covering helps to maintain a more stable moisture content and prevents rapid drying, allowing for better curing and development of strength compared to air-drying, where the material is exposed to environmental conditions which could lead to uneven drying and weaker overall strength. In summary, the order of curing methods from highest to lowest compressive strength would be water immersion, intermittent sprinkling, wet rug covering, plastic sheet covering, and air drying. The result agrees with earlier studies (Olofinnade et al., 2017; Rekha & Jayaramappa, 2018). Table 2 compares the compressive strength of concrete under water immersion to the compressive strength of the other curing methods.

Table 2. Comparative analysis of compressive strength: water immersion versus other curing methods in laterized concrete

%Laterite Content	Curing Method	Compressive strength, N/mm2						Strength ratio, (%)							% Reduction
		d1	d3	d7	d14	d21	d28	d1	d3	d7	d14	d21	d28	Average	
0	Water Immersion	5.76	12.80	20.80	28.80	31.04	31.68	100	100	100	100	100	100	100	
	Intermittent Sprinkling	5.18	11.52	18.93	26.21	28.56	29.12	90.00	90.00	91.00	91.00	92.00	91.92	90.99	9.01
	Wet Rug Covering	4.84	10.62	17.26	24.55	26.07	26.23	84.00	83.00	83.00	85.23	84.00	82.79	83.67	16.33
	Plastic Sheet Covering	4.61	10.11	16.43	22.75	24.57	25.38	80.00	79.00	79.00	79.00	79.17	80.11	79.38	20.62
	Air-Drying	3.97	8.70	14.56	19.53	21.11	21.89	69.00	68.00	70.00	67.80	68.00	69.11	68.65	31.35
10	Water Immersion	5.09	12.35	20.68	27.17	30.25	30.87	100	100	100	100	100	100	100	
	Intermittent Sprinkling	4.58	10.83	18.48	24.15	27.23	27.58	90.00	87.67	89.33	88.89	90.00	89.36	89.21	10.79
	Wet Rug Covering	4.28	10.29	17.10	22.25	25.11	25.65	84.00	83.33	82.70	81.90	83.00	83.10	83.01	16.99
	Plastic Sheet Covering	3.97	9.73	16.36	21.55	23.75	24.45	77.89	78.77	79.11	79.33	78.50	79.21	78.80	21.20
	Air-Drying	3.46	8.47	14.29	18.20	20.61	21.30	68.00	68.57	69.10	67.01	68.11	69.00	68.30	31.70
20	Water Immersion	4.75	11.58	19.00	25.83	28.21	29.69	100	100	100	100	100	100	100	
	Intermittent Sprinkling	4.18	10.47	16.70	23.25	25.10	25.24	88.00	90.44	87.90	90.00	89.00	85.00	88.39	11.61
	Wet Rug Covering	3.90	9.73	15.64	21.44	23.35	24.48	82.00	84.00	82.30	83.00	82.80	82.46	82.76	17.24
	Plastic Sheet Covering	3.73	9.15	14.80	20.24	22.28	23.30	78.53	79.00	77.87	78.34	79.00	78.48	78.54	21.46
	Air-Drying	3.23	7.89	12.92	17.56	19.18	19.86	68.00	68.12	68.00	68.00	68.00	66.89	67.84	32.16
30	Water Immersion	4.34	10.91	17.34	24.61	26.85	27.97	100	100	100	100	100	100	100	
	Intermittent Sprinkling	3.90	9.71	15.61	21.41	23.09	24.89	90.00	89.00	90.00	87.00	86.00	89.00	88.50	11.50
	Wet Rug Covering	3.55	9.23	14.39	20.43	22.13	23.53	82.00	84.60	83.00	83.00	82.43	84.12	83.19	16.81
	Plastic Sheet Covering	3.47	8.51	13.74	19.69	21.21	22.16	80.00	78.00	79.24	80.00	79.00	79.22	79.24	20.76
	Air-Drying	2.93	7.32	11.81	16.74	18.23	19.02	67.69	67.12	68.12	68.00	67.89	68.00	67.80	32.20
40	Water Immersion	3.91	9.53	17.34	21.51	23.46	24.44	100	100	100	100	100	100	100	
	Intermittent Sprinkling	3.40	8.58	15.61	19.36	21.12	21.75	87.00	90.00	90.00	90.00	90.00	89.00	89.33	10.67
	Wet Rug Covering	3.23	7.89	14.17	17.90	19.73	20.06	82.50	82.80	81.70	83.22	84.11	82.08	82.74	17.26
	Plastic Sheet Covering	3.09	7.63	13.59	16.72	19.00	19.53	79.00	80.00	78.34	77.76	81.00	79.93	79.34	20.66
	Air-Drying	2.65	6.48	11.71	14.84	15.95	16.62	67.88	68.00	67.51	69.00	68.00	68.00	68.07	31.93
50	Water Immersion	3.52	8.08	12.85	18.24	19.90	20.73	100	100	100	100	100	100	100	
	Intermittent Sprinkling	3.21	7.03	11.57	16.42	17.47	18.03	91.00	87.00	90.00	90.00	87.80	87.00	88.80	11.20
	Wet Rug Covering	2.93	6.95	10.86	15.14	16.52	17.20	83.00	86.00	84.50	83.00	83.00	83.00	83.75	16.25
	Plastic Sheet Covering	2.71	6.39	10.41	14.33	16.12	16.37	76.89	78.99	81.00	78.54	81.00	79.00	79.24	20.76
	Air-Drying	2.40	5.58	8.80	12.59	13.53	13.92	68.23	69.00	68.50	69.00	68.00	67.16	68.32	31.68

The sorptivity of laterized concrete cylinder specimens was evaluated under various curing methods and different percentages of laterite content. Overall, the results indicate that increasing the laterite content in the concrete mixture tends to increase the sorptivity and the rate of change. As an illustration, Figure 5 displays the 28-day sorptivity of the concrete containing varying content of laterite under water immersion curing conditions. There is a clear trend of increasing sorptivity with an increase in laterite content, as demonstrated by the rise in sorptivity from 0.0377 to 0.0589 with an increase in laterite content from 0% to 50%. This finding corroborates that of earlier investigation (Onipe & Fologbade, 2017). Two potential reasons can account for this observation: Firstly, higher laterite content may compromise the workability of concrete, affecting compaction and consequently, sorptivity. Secondly, the presence of laterite might introduce additional porosity into the concrete matrix, thereby reducing its density and subsequently, its sorptivity. The rate of change in sorptivity demonstrates a consistent pattern of increase as the laterite content increases in the concrete mixture. At 10% laterite replacement, there is a moderate increase of approximately 2.91%. However, this increase becomes more pronounced with higher levels of laterite replacement. At 20% replacement, the rate of increase accelerates to around 13.80%, indicating a more substantial impact on sorptivity. This trend continues with even greater intensity at 30%, 40%, and 50% laterite replacement, where the rates of change reach approximately 25.40%, 39.26%, and 56.21% respectively. These findings suggest a nonlinear relationship between laterite content and sorptivity, with higher levels of replacement exerting increasingly significant increases in water absorption.

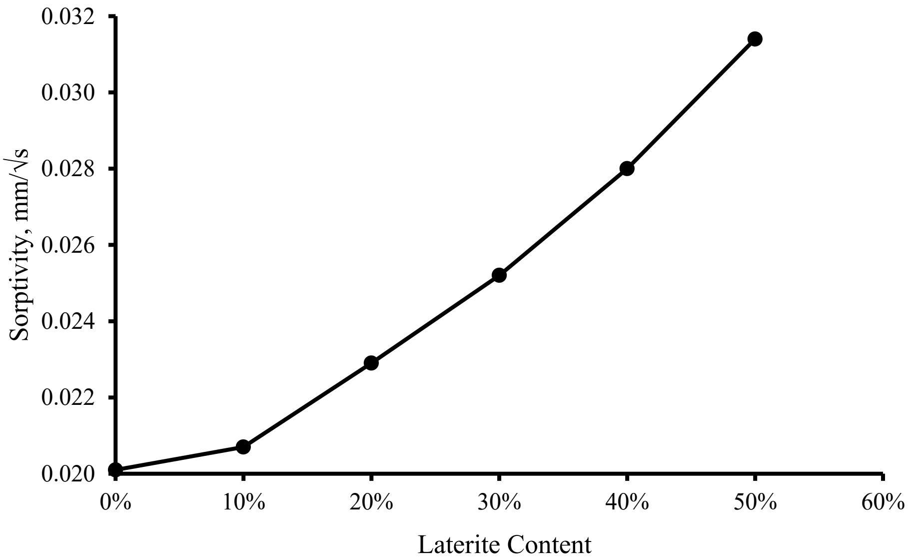


Figure 5. 28-Day Sorptivity of concrete with different laterite content under water immersion conditions

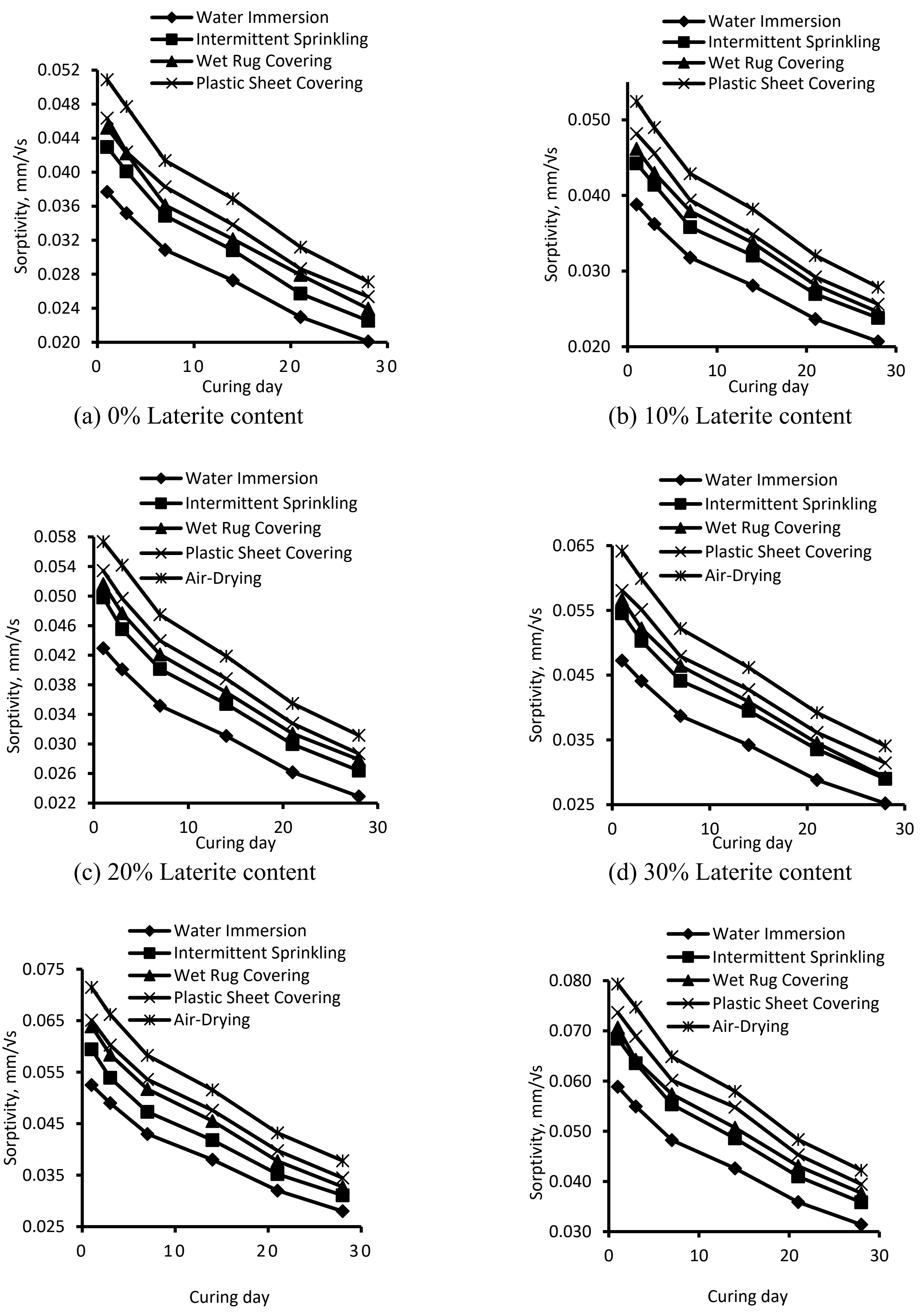
As the curing process progresses, the sorptivity generally diminishes across the various curing techniques as indicated in Figure 6, an observation that is consistent with the result of prior studies on normal and other alternative concrete (Kubissa *et al*., 2022; Potdar *et al*., 2023). This pattern implies that as the material absorbs moisture and experiences hydration, its capacity for further water absorption reduces. This phenomenon may be ascribed to the formation of hydration products and the filling of the pores, thereby decreasing the volume accessible for water absorption. It was also noted that the rate of decrease of the sorptivity is not uniform or consistent over time, as is the case in concrete compressive strength development, an observation that may be attributed to the dynamic interplay of hydration reactions, moisture transport, and changes in pore structure during the curing period. During the curing process, the sorptivity of the laterized concrete specimens shows a consistent decrease over time. Within the first three days of curing, there is a rapid reduction in water absorption, with an average daily decrease of 4.32%. This significant decrease could be attributed to the immediate hydration reactions within the concrete matrix. As curing progresses from day 3 to day 7, the rate of decrease drops slightly to around 2,97% per day. This drop may be due to the continued formation of hydration products, and therefore reduced permeable pores and pore connectivity. From day 7 to day 14, the average daily decrease further diminishes to about 1.67%. However, as the concrete approaches maturity (from day 14 to day 21), there is a modest acceleration in the rate of decrease, with an average daily decrease of approximately 2.22%. Towards the end of the curing process (from day 21 to day 28), the average daily decrease remains relatively consistent at around 1.71%. The steady but slower decline in water absorption may indicate that the concrete is nearing its maximum resistance to moisture, with most of the pores filled and hydration reactions nearing completion.

Figure 6 also illustrates that the sorptivity of the concrete varies with the curing method employed at each level of laterite replacement. Among the curing methods investigated, water immersion consistently exhibited the lowest sorptivity values across all laterite content percentages and curing durations. This suggests improved resistance to water penetration over time and is likely due to the continuous saturation of the specimens, facilitating the complete hydration process and leading to denser concrete microstructures.

The next curing method is intermittent sprinkling. Intermittent sprinkling demonstrates lower sorptivity than wet rug covering across all curing durations, providing controlled and periodic wetting, ensuring more uniform moisture distribution throughout the concrete. Wet rug covering consistently exhibits lower sorptivity than plastic sheet covering. This difference may be due to the wet rug covering providing a layer of damp fabric directly in contact with the concrete surface, which effectively retains moisture and promotes more uniform moisture distribution throughout the curing period.

Lastly, plastic sheet covering shows lower sorptivity compared to air-drying at all curing durations. This difference is likely because the plastic sheet creates a barrier to moisture loss, while air-drying allows for rapid evaporation, leading to higher sorptivity.

In summary, the curing methods rank in decreasing order of sorptivity as follows: water immersion, intermittent sprinkling, wet rug covering, plastic sheet covering, and air-drying. These results are congruent with prior studies in which the effects of some of the curing methods on the sorptivity of concrete were investigated (Esam *et al*., 2014; H. Wang *et al*., 2023). Table 3 presents a comparison between the compressive strength of concrete under water immersion and that of the other curing methods.



(a) 0% Laterite content

(b) 10% Laterite content

(c) 20% Laterite content

(d) 30% Laterite content

(e) 40% Laterite content

(f) 50% Laterite content

Figure 6. Sorptivity variation of concrete (incorporating varying laterite replacement levels) across different curing conditions and ages

Table 3. Comparative study on sorptivity: water immersion compared to alternative curing methods in laterized concrete

%Laterite Content	Curing Method	Sorptivity, mm/√s						Sorptivity ratio, (%)							% Increase
		d1	d3	d7	d14	d21	d28	d1	d3	d7	d14	d21	d28	Average	
0	Water Immersion	0.0377	0.0352	0.0309	0.0273	0.0230	0.0201	100	100	100	100	100	100	100	
	Intermittent Sprinkling	0.0430	0.0401	0.0349	0.0308	0.0257	0.0225	114.00	114.00	113.00	113.00	112.00	112.09	113.02	13.02
	Wet Rug Covering	0.0452	0.0422	0.0361	0.0321	0.0279	0.0240	120.00	120.00	117.00	117.77	121.54	119.21	119.25	19.25
	Plastic Sheet Covering	0.0464	0.0424	0.0383	0.0338	0.0286	0.0254	123.00	120.46	124.00	124.00	124.68	126.19	123.72	23.72
	Air-Drying	0.0509	0.0477	0.0414	0.0369	0.0312	0.0271	135.00	135.67	134.00	135.20	135.78	134.89	135.09	35.09
10	Water Immersion	0.0388	0.0362	0.0318	0.0281	0.0237	0.0207	100	100	100	100	100	100	100	
	Intermittent Sprinkling	0.0442	0.0414	0.0358	0.0321	0.0270	0.0238	114.00	114.33	112.67	114.11	114.00	115.00	114.02	14.02
	Wet Rug Covering	0.0462	0.0430	0.0379	0.0337	0.0281	0.0246	119.00	118.67	119.30	120.10	118.99	118.78	119.14	19.14
	Plastic Sheet Covering	0.0482	0.0456	0.0394	0.0348	0.0292	0.0256	124.11	125.78	123.89	123.89	123.50	123.79	124.16	24.16
	Air-Drying	0.0524	0.0490	0.0429	0.0382	0.0321	0.0279	135.11	135.24	134.90	135.99	135.49	134.66	135.23	35.23
20	Water Immersion	0.0429	0.0401	0.0352	0.0311	0.0262	0.0229	100	100	100	100	100	100	100	
	Intermittent Sprinkling	0.0498	0.0455	0.0401	0.0354	0.0300	0.0264	116.00	113.56	114.10	113.89	114.50	115.24	114.55	14.55
	Wet Rug Covering	0.0516	0.0477	0.0421	0.0370	0.0314	0.0279	120.23	119.00	119.70	119.00	120.00	121.78	119.95	19.95
	Plastic Sheet Covering	0.0534	0.0497	0.0440	0.0388	0.0328	0.0287	124.47	124.00	125.01	124.89	125.23	125.25	124.81	24.81
	Air-Drying	0.0574	0.0542	0.0475	0.0419	0.0355	0.0312	133.60	135.19	135.00	134.70	135.56	136.11	135.03	35.03
30	Water Immersion	0.0473	0.0441	0.0387	0.0342	0.0288	0.0252	100	100	100	100	100	100	100	
	Intermittent Sprinkling	0.0545	0.0503	0.0441	0.0395	0.0335	0.0290	115.44	114.00	114.00	115.47	116.44	115.00	115.06	15.06
	Wet Rug Covering	0.0567	0.0522	0.0464	0.0409	0.0345	0.0292	120.00	118.40	120.00	119.56	119.88	115.88	118.95	18.95
	Plastic Sheet Covering	0.0581	0.0551	0.0479	0.0428	0.0361	0.0314	122.89	125.00	123.76	125.00	125.50	124.78	124.49	24.49
	Air-Drying	0.0642	0.0599	0.0522	0.0462	0.0392	0.0341	135.78	135.88	134.88	135.00	136.11	135.23	135.48	35.48
40	Water Immersion	0.0525	0.0490	0.0430	0.0380	0.0320	0.0280	100	100	100	100	100	100	100	
	Intermittent Sprinkling	0.0594	0.0539	0.0473	0.0418	0.0352	0.0311	113.22	110.00	110.00	110.00	110.00	111.00	110.70	10.70
	Wet Rug Covering	0.0639	0.0584	0.0517	0.0455	0.0377	0.0327	121.75	119.20	120.30	119.78	117.89	116.92	119.31	19.31
	Plastic Sheet Covering	0.0651	0.0603	0.0536	0.0476	0.0398	0.0345	124.00	122.97	124.66	125.24	124.23	123.07	124.03	24.03
	Air-Drying	0.0715	0.0662	0.0583	0.0516	0.0432	0.0378	136.12	135.11	135.49	135.67	135.00	135.00	135.40	35.40
50	Water Immersion	0.0589	0.0550	0.0482	0.0426	0.0359	0.0314	100	100	100	100	100	100	100	
	Intermittent Sprinkling	0.0684	0.0635	0.0553	0.0486	0.0410	0.0358	116.22	115.64	114.77	114.00	114.23	114.11	114.83	14.83
	Wet Rug Covering	0.0707	0.0642	0.0574	0.0507	0.0431	0.0377	120.00	116.89	118.98	118.98	120.00	120.00	119.14	19.14
	Plastic Sheet Covering	0.0737	0.0689	0.0602	0.0548	0.0453	0.0394	125.11	125.40	124.74	128.60	126.23	125.60	125.95	25.95
	Air-Drying	0.0793	0.0747	0.0649	0.0580	0.0483	0.0422	134.77	136.00	134.50	136.00	134.67	134.48	135.07	35.07

The results of this study demonstrate that curing methods impact the sorptivity of laterized concrete. Immersion in water and intermittent sprinkling proved to be the most effective methods in reducing sorptivity, followed by covering with a wet rug and plastic sheet covering, while air-drying is the least effective.

The data in Tables 2 and 3 indicate an inverse relationship between compressive strength and sorptivity. The curing methods that enhance compressive strength (e.g., water immersion) tend to reduce the water absorption rate. Conversely, methods resulting in lower compressive strength (e.g., air-drying) exhibit higher sorptivity. As the curing duration increases for all the methods employed, the compressive strength increases while the sorptivity reduces.

4. CONCLUSIONS AND RECOMMENDATIONS

In conclusion, this study has thoroughly examined the intricate relationship between curing methods, compressive strength development, and sorptivity in laterized concrete. The findings underscore the significant impact of laterite content, curing duration, and curing method on the mechanical and durability properties of concrete.

Laterized concrete incorporating laterite as a replacement for sand emerges as a sustainable alternative for construction, particularly in regions blessed with ample laterite resources. However, it's crucial to recognise that the compressive strength of laterized concrete is intricately influenced by factors such as laterite content, curing duration, and curing method. Higher laterite content generally leads to reduced strength, while also increasing sorptivity, thereby impacting durability and resistance to environmental degradation.

Curing methods play a pivotal role in both compressive strength development and sorptivity. Water immersion proves most effective in enhancing strength and reducing water absorption, followed by intermittent sprinkling, wet rug covering, plastic sheet covering, and air-drying in decreasing order of effectiveness. Notably, an inverse relationship exists between compressive strength and sorptivity, where methods enhancing strength tend to reduce water absorption rate, and vice versa.

These findings furnish valuable insights for optimising concrete mixtures and curing practices to enhance structural performance and durability. Understanding the behaviour of laterized concrete not only aids in promoting sustainability and resilience in infrastructure development but also holds particular significance in regions endowed with abundant laterite resources. Embracing local materials and knowledge can pave the way for long-term improvements in infrastructure performance.

AUTHOR CONTRIBUTIONS

Mark Omeiza ONIPE: Drafted and wrote the manuscript, performed the experiment and result analysis.
Ngozi Florence NWODI: Supervised the experiment's progress and helped in manuscript preparation.
Charles Chukwudifu CHIME: Supervised the experiment's progress and helped in manuscript preparation.

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This study does not require any ethics committee approval.

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