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The Compressive Strength and Durability Indices of Concrete Produced from Nigerian Grade 42.5 Portland Limestone Cements Relative to its Application in Southern Nigeria

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Abstract:
Background*: Durability and strength are two inseparable indices of concrete and mostly in areas where the concrete is being subjected to severe exposure conditions. Bayelsa state alongside most states in the Niger Delta Region of Nigeria, in searching for a stable foundation for buildings, locate their footings at submerged levels below natural ground water table. The effect of continuous immersion of concrete on weight loss and strength for varying brands of Nigerian Grade 42.5 Portland limestone cement is therefore timely as we drive towards a more engineered and sustainable infrastructure.*
Materials and Methods*: In this study, Compressive strength and durability performance of concrete made with the Nigerian top five brands (Dangote Cement, BUA Cement, Superset, Ibeto Cement, and United Cement Company of Nigeria) of Portland limestone cement (PLC) grade 42.5N was examined.*
The coefficient of water absorption (Water Absorption Index) as well as the concrete strength due to immersion was investigated. Six (6) concrete specimens each were produced for each brand, and results taken for 7, 14, 21 and 28 days to enable close comparison on the performance of the various brands in a submerged environment.
Results*: According to the physical results, Dangote, Ibeto, and Unicem had specific gravities outside the specified range of 3.1 - 3.15; Dangote and UniCem had consistencies outside the specified range of 25 - 30%; all cement brands met the initial and final setting times and soundness specifications; Dangote and Supaset did not meet the fineness specifications. From the compressive strength investigation, all cement brands met the minimum criteria for grade M15 concrete, which was over 20.78 N/mm^2. Only BUA concretes met the 4–6% water absorption criteria , whereas all other brands exhibited sorptivities below 10%.*
Conclusion: *This study shows that cement fineness is crucial to concrete strength and durability. In lieu of improved quality control and assurance in the Nigerian cement industry, SON should undertake frequent inspections to guarantee compliance. This is especially important for concrete structures that are constantly submerged in water, as fineness affects sorptivity and strength.*
Key Word*: Portland Limestone Cement; Compressive Strength; Water Absorption Index;*

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I. Introduction

Water is the most common man-made construction material, followed by concrete as the most widely used material worldwide[1]. It is made by proportionately combining cementitious ingredients, water, and aggregate (and occasionally admixtures. Concrete is made up of aggregates embedded in a cement matrix that fills the voids between the particles and holds them together[2]. Concrete has been used for construction since before the Roman Empire and is a remarkably durable material. After being put in a form and given time to cure, the concrete mixture solidifies into a mass that resembles rock. Concrete should have the following qualities when it is hardened: strength, durability, impermeability, and minimal dimensional changes. The attributes of the components, mix percentage, compaction technique, and other variables during placement, compaction, and curing all affect the concrete's strength, durability, and other qualities[1]. The concrete's compressive strength is regarded as the most crucial of its many characteristics and is used as a gauge of its general quality.
According to [3], concrete gains strength quickly at an early age as opposed to later ages, averaging 26% of the 28-day strength in 1 day and 85% in 21 days. A society may be positively or negatively impacted by the quality of the concrete material. The usage of inferior materials, especially concrete, has been cited by [4] as the primary cause of building collapse in Nigeria. According to [5], the water to cement ratio has the most impact

on concrete strength, the aggregate to water ratio has an impact on workability, and the aggregate cement ratio has an impact on cost. Numerous other aspects, including aggregates, cement, mixing techniques, operator skill, placement, and consolidation, make it difficult to certify the quality of concrete as its variety grows. Numerous factors influence it, including the competence of the manufacturers, management placement techniques, environmental concerns, and the quality of the constituent materials (cement aggregates, water, and admixtures)[6,7]

According to [8], the main elements influencing concrete's strength are the paste and aggregates. According to [9], the consistency of the cement paste and the type of coarse aggregate primarily determine the strength of the concrete at the interfacial ppzone. The chemical reaction between the cement and water gives Portland cement paste its binding properties[11]. The porosity and, in turn, the strength are directly impacted by the degree of cement hydration, which is determined by the water to cement ratio. One of the elements that influences how quickly a concrete mix develops strength is its richness, which is directly correlated with the calibre and amount of cementitious material used. A significant number of research papers on Portland limestone cement concrete have been produced by the Nigerian concrete industry. Nonetheless, the majority of these studies concentrate on either strength development research or strength comparison analysis of concrete manufactured from the accessible cement grades [12,13]. Others concentrated on determining the quality of cement grades [14]. In Nigeria, cement comes in grades 32.5 and 42.5 (in the classes of N, which stands for ordinary early strength; R, which stands for high early strength; and S, which stands for standard strength). There are few publications detailing studies on the durability properties of concrete made with Portland limestone cement. It is accurate to say that, up until recently, advancements in cement and concrete technology focused on increasing strengths under the presumption that durable concrete is strong [15]. It is widely recognised that both strength and durability must be specifically taken into account during the design phase for many concrete structure exposure circumstances. Additionally, the construction industry uses a variety of brands of Portland cement that are sold in markets. Various groups in the building business have conducted subjective and unverified evaluations comparing the available cement brands based on factors including compressive strength, fineness, workability, and setting time. Therefore, a proper independent academic study to determine the characteristics of each of the various cement brands is long overdue.

This study will therefore assess the impact of certain Portland cement brands on the mechanical properties of concrete in order to address the disparity in concrete compressive strength and durability produced by various brands of Portland cement available on the market.

II. Material And Methods

Materials: Locally produced Portland-limestone cement of grade 42.5N from Nigeria was used in this investigation. All of the concrete mixes contained zone 3 sharp sand that was finer than 4.75 mm in sieve size and crushed aggregate with a maximum size of 20 mm. In order to mix the concrete, portable water was used.

Mix Design: For all cement brands, a cement-sand-granite nominal mix design ratio of 1:2:4 was used, (seeing this is the most widely used grade of concrete in Southern Nigeria), at a constant water-cement ratios of 0.5. All of the constituents of concrete were calculated using the mass of the concrete cube specimen, which measured 150 mm × 150 mm × 150 mm. Six cubes of concrete specimens were cast for each cement brand and curing time., amounting to a total of sixty cube specimens. At each curing age, the moisture absorbed due to immersion for a specific grade is estimated prior to the crushing of the concrete specimen for compressive strength determination.

Test Location: Every test was carried out at the Civil Engineering Departmental Laboratory of Niger Delta University, in Bayelsa State, Nigeria. Experiments were performed on the raw materials for classification as well as on both freshly mixed and hardened concrete in compliance with their corresponding standards.

Test Methods:

1. Particle Size Distribution: Only the fine aggregates were subjected to the sieve analysis. Using a weighing balance, electric oven, brushes, scoop, and British standard test sieves of sizes 5mm, 4.75mm, 3mm, 2.36mm, 1.70mm, 0.6mm, 0.5mm, 0.212mm, 0.150mm, 0.075mm, and pan, 300 g of the oven-dried river sand was run through a series of sieves to ascertain the percentage passing the respective sieve sizes. The weights of the samples maintained on each sieve were measured and expressed in terms of the total weight passed through the sieve set after the samples were agitated vigorously for 3 minutes. The coefficient of uniformity parameters obtained from the particle size distribution curve is used to indicate the distribution/grading type of different size particles. When the particle sizes are dispersed over a large range and the coefficient of uniformity is larger than 6 and the coefficient of curvature value falls between 1 and 3, the aggregate is said to be well graded (SW), otherwise, the sand is considered poorly graded (SP)

$$\text{Coefficient of Uniformity (Cu)} = \frac{D60}{D10} - - - - - (1)$$

$$\text{Coefficient of Curvature (Cc)} = \frac{(D30)^2}{(D10 * D60)} - - - - - (2)$$

2. Specific Gravity Test:

The weight of a particular volume of cement of a substance in air divided by the weight of an equivalent volume of a standard substance (water) at a specific temperature of 40^o is known as specific gravity, or relative density. After the cylinder was cleaned and dried, it was weighed emptied and its weight was noted as W1. The cylinder was then filled with room-temperature water, and both the water and the cylinder were weighed as W3. After emptying and drying the cylinder, a sizable portion of the sample was added, and the weight was noted as W2. Water was then added to the sample to the same mark as W1, covered, and shaken well to eliminate any air bubbles or suspended particles in the soil solution. Finally, the sides of the cylinder was dried with a piece of cloth and weighed as W4. In accordance to BS EN 197-1 (2011), the specific gravity was obtained using the equation (3)

$$\text{Specific Gravity (RD)} = \frac{(W2-W1)}{(W4-W1)-(W3-W2)} \text{ ------------ } (3)$$

3. Conistency Test:

The cement's fluidity is measured by consistency using the Vicat's equipment maintained at a steady 25 °C or 29 ^{o}C and with a steady 20% humidity level. Every time cement and water are combined during the test, the amount of water injected varies between 24 and 27% of the cement's weight. Using a Vicat apparatus fitted with a plunger that is 10 ± 1 mm in diameter and 50 mm long, it is possible to freely penetrate a depth of 33–35 mm (from top) or 5-7 mm (from bottom) to assess the quality of water required to generate a paste of standard consistency. Three hundred grams (300g) of cement powder were measured using an electronic weighing scale. 25% of the cement powder's weight, or 75g, was computed and weighed in order to calculate the amount of water needed. Using a hand trowel, a 75g cement and water mixture was carefully prepared on a mixing tray. After making sure the surface was properly polished, the resultant mixture was poured into the Vicat mould, allowing the plunger of the Vicat's mechanism to come into touch with the top of the cement as specified, which is 26–32%[16, 17]. Equation (4) was used to determine the standard consistency of the different brands of cement tested;

$$\text{Standard Consistency} = \frac{(W2)}{(W1)} * 100 \text{ ------------ } (4)$$

Where;
W1 = Weight of Cement (g)
W2 = Weight of Water (g)

4. Setting Time:

The process for cement setting time was outlined in [18,19] , wherein 300g of cement powder was measured with an electronic weighing scale, and 25% of 300g was computed as mass of water. The period that passes between adding water to the cement and the paste losing its fluidity when a rod-bearing needle measuring 1 mm^2 penetrates 33–35 mm deep into cement paste is known as the initial setting time.

The test block resting on the plate and enclosed in the mould was placed beneath the rod holding the needle in order to determine the initial setting time. The rod was gently lowered into contact with the test block's surface, swiftly released, and allowed to sink into the block. This procedure is continued until the needle does not pierce past a point about 5 mm from the bottom of the mould when it is brought into contact with the test block and released as previously mentioned. The first setting time is the amount of time that passes between adding water to the cement and the point at which the needle stops puncturing the test block as previously mentioned.

Between 14 and 18 ^{o}C, in an atmosphere with at least 90% relative humidity, 300g of cement sample was weighed and mixed with 0.85 times the amount of water needed to create cement paste of standard consistency. When the water was put to the cement sample, the stopwatch began. After being made according to regular procedure, the paste filled the Vicat's mould in three to five minutes. Through its attachment to the Vicat's equipment, the needle was able to softly touch the test block's surface before being swiftly released to facilitate

penetration. The test block is initially fully punctured by the needle, but this is repeated every two minutes until the block seems to be penetrated beyond 5.0 ± 0.5 mm measured from the mold's bottom.
The Vicat apparatus's needle was swapped out with a circular or annular attachment that has a central needle and a circular cutting-edge part in order to calculate the final setting time.
The circular needle left an impression after reducing the circular attachment over time, however the circular cutting edge left no impression. The final setting time is the amount of time it takes for the circular cutting edge to fail to leave an impression. When the needle leaves an impression on the test block's surface after being gently applied, but the attachment does not, the cement is said to be fully set. The amount of time that passes between adding water to the cement and the paste totally losing its ductility is known as the final setting time.
According to [18,19], the PLC's final setting duration should not surpass 600 minutes, and its initial setting time should not be less than 60 minutes.

5. Soundness Test:
Cement soundness denotes its capacity to preserve volume post-setting and hardening, hence averting excessive expansion or contraction that may result in cracks within concrete buildings. This is accomplished by regulating the levels of free lime and magnesia in the cement[20]. The methodology for assessing the soundness of cement is well described[18]. The deterioration of cement results from prolonged water retention at elevated temperatures[21]. These compounds are recognised for their delayed reaction with water (H_2O), significantly increasing volume, which leads to cracking, deformation, and disintegration, as assessed by either the Le-Chatelier or Autoclave method.
The soundness of cement is deemed acceptable within the range of 0.5 to 2.0 mm, but the specification indicates that a permissible limit of not more than 10 mm for the cement should be classified as sound. During the execution of this test, the mould is positioned on glass and filled with cement paste containing 22% by weight of water, ensuring that the split of the mould remains gently closed throughout the process. The mould was subsequently covered with an additional glass piece, onto which a little weight was applied, and the entire assembly immersed in water at a temperature ranging from 27 ± 2 °C, for a duration of 24 hours. The mould was further submerged in a boiling water for 3 hours, extracted from the water and permitted to cool, after which the distance between the spots was remeasured; the variance between the two measurements signifies the expansion of the cement. The soundness of the cement brands was estimated from Equation (5).

$$\text{Soundness} = D1 - D2 \quad --------- (5)$$

D1 denotes the measurement taken after a 24-hour immersion in water at a temperature of roughly 27 ± 2 °C, whereas D2 signifies the measurement acquired following a 3-hour immersion in boiling water.

6. Fineness Test :

The ratio of specific surface area of cement particles per mass is a representation of the fineness of the cement, given in m²/kg or cm²/g. Fineness is assessed using Blaine's air permeability test, Wanger turbidimeter, or the sieve test. From the sieve test approach, the percentage of cement kept on 45, 90, and 300 µm sieves must not surpass 10%, as stipulated in [22], or 10 - 30% as specified by [18] for 40 µm test sieve. This experiment assessed the fineness of Dangote, BUA, Supaset, Ibeto , and UniCem using sieve testing. The air-set lumps were fractured, and PLC samples were constantly sieved in a circular and vertical motion for 3 minutes. The residue remaining on the sieve is denoted as W1, and the total test sample mass is denoted as W2. Fine cement exhibits greater strength and produces more heat than coarse cement. Fine cement enhances cohesiveness, diminishes bleeding, and increases resistance to shrinkage and cracking. The extent of cement hydration is affected by the fineness of the cement. The greater the fineness, the enhanced workability and permeability of the cement paste which ultimately reduces needed water content; enhances density and promotes the compressive and durability indices of the hardened cement structure.

7. Concrete Workability Test:
The slump test evaluates the consistency of fresh concrete. It serves, indirectly, as a method for verifying that the appropriate quantity of water has been incorporated into the mixture. The examination is conducted in compliance with [23], which pertains to the testing of fresh concrete.
The steel slump cone was positioned on a stable, impermeable, level surface and filled with fresh concrete in three uniform levels. Each layer was compacted by being rodded 25 times. The third layer was completed flush with the apex of the cone. The cone was meticulously elevated, resulting in a mound of concrete that settles or 'slumps' marginally. The inverted slump cone was positioned on the base as a reference, and the elevation

difference between its apex and the surface of the concrete measured and documented to the nearest 10mm to determine the concrete's slump.

8. Compresive Strength Test:
In accordance to [24], Three (3) concrete cube specimens of 150mm * 150mm * 150mm, of grade M15, was produced for each cement brand and per curing age, resulting to a total of 120 concrete cube specimens. The mass of each cube was recorded prior to crushing, and the density as well as compressive strengths determined. Concrete compressive strength is estimated as ;

$$\text{Compressive Strength} = \frac{P}{A} \text{ in N/mm}^2 \text{ ---------------------- (6)}$$

9. Durability Test (Water absorption):

The durability of the cement brands cannot be estimated directly, however, in concrete, the resistance to moisture penetration due to the cement bond and density, is an indices of the cement's contribution to concrete durability. Water absorption index (WAI) necessitated the production of cube specimens (three specimens per cement brand per day) with conventional cube dimensions of 150mm. Water Absorption Test, in accordance with [25], was performed on the specimens to determine the water retention capacity of the concrete samples. Water absorption data were analyzed at 7, 14, 21, and 28 days, following the guidelines of [25]. Following immersion curing, they were oven-dried at 105 ± 5 °C for 72 hours, and the resulting weight was recorded as W1. Subsequently, the specimens were immersed in water for 24 hours, and the resulting weights were recorded as W2. The percentage of the difference between the weights before immersion (oven-dried weight, W1) and after immersion (W2) relative to the oven-dried weight (W1) represents the water absorption capacity of the concrete specimen, documented as an index.

$$\text{WAI (\%)} = \frac{(W2 - W1) \times 100}{W1} \text{ ---------------- (7)}$$

III. Result

3.1. Particle Size Distribution Result:

The summary of results obtained for the particle size distribution are shown in Table 1:

Table 1: Summary of Particle size distribution of Fine Aggregate

D60	1.8	mm	Cu = D60/D10	4.5
D30	1.18	mm	CC = $D30^2$/D10*D60	1.93
D10	0.4	mm	FM	3.72

Figure 1 is the chart of the particle size distribution of the fine aggregate;

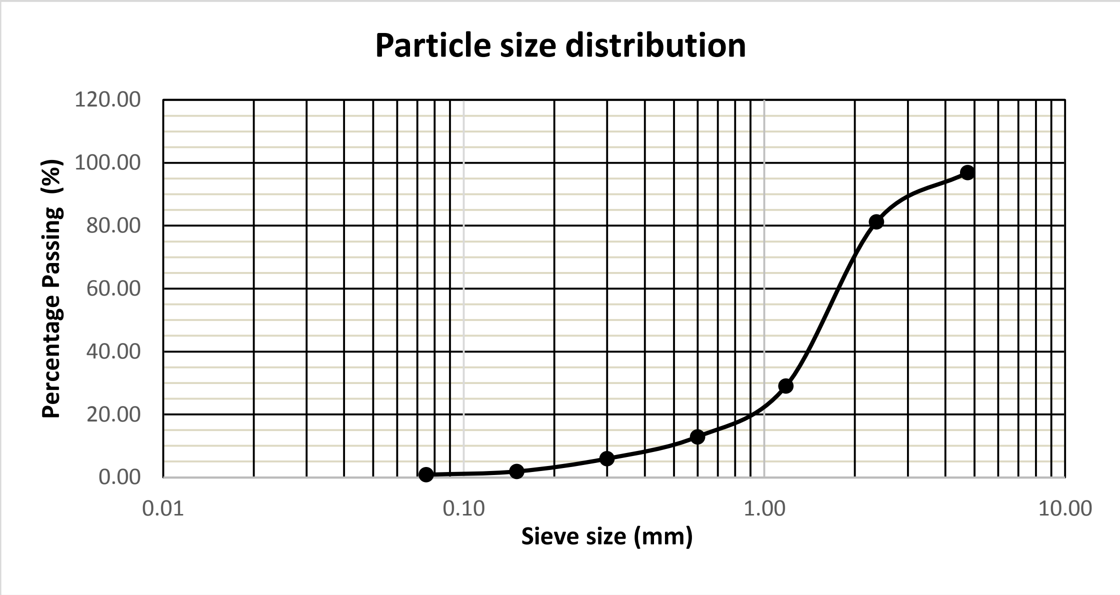


Figure 1: Particle size distribution for the fin aggregate

From the particle size distribution, it is shown that the fine aggregate falls under the category of poorly graded sand having a coefficient of uniformity of 4.5, which is less than 6.

3.2. Specific Gravity :

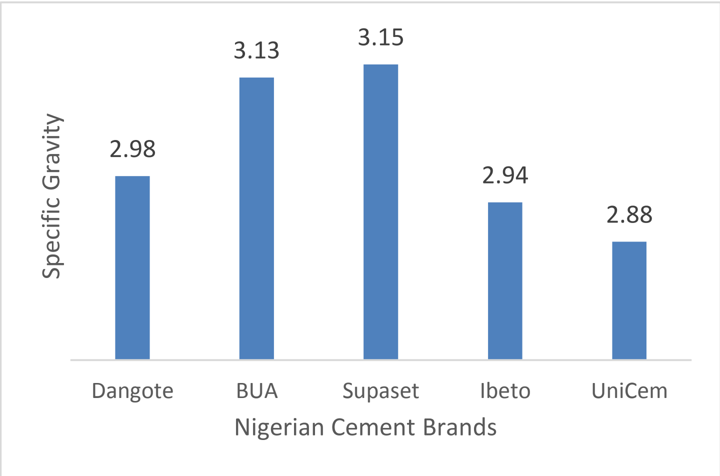


Figure 2: Specific gravity of Nigerian grade 42.5N Portland Limestone cement

The specific gravites obtained for Dangote, BUA, Supaset, Ibeto and UniCem as shown in Figure 2, are 2.98, 3.13, 3.15, 2.94, and 2.88 respectively. This is to say that Supaset s the highest unit weight, while UniCem when compared to the other brands, has the lowest unit weight.

3.3. Standard Consistency:

The percentage of water by weight of the cement that brings the mix to a standard fluidity is of utmost importance, as its directly relative to the water to cement ratio of cement mixes, such that, increasing consistencies, increased the required water-cement ratio, which ultimately leads to reduction in durability and compressive strength. The standard consistency results obtained for the various cement brands are shown in Figure (3).

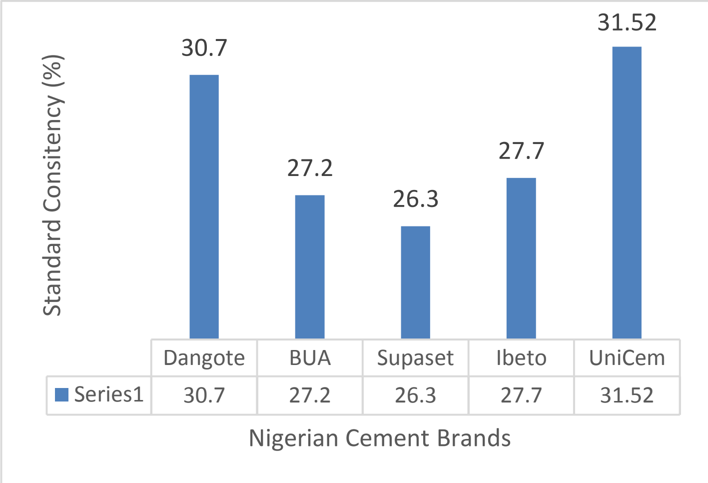


Figure 3: Standard Consistencies of Nigerian grade 42.5N Portland Limestone cement

The standard consistences obtained for Dangote, BUA, Supaset, Ibeto and UniCem as shown in Figure 3, are 30.7, 27.2, 26.3, 27,7, and 31.5% respectively. This is to say that Supaset is the lowest in consistency, while UniCem and Dangote, when compared to the other brands require the highest amount of water to achieve optimum fluidity of cement paste.

3.4 Initial Setting Time:

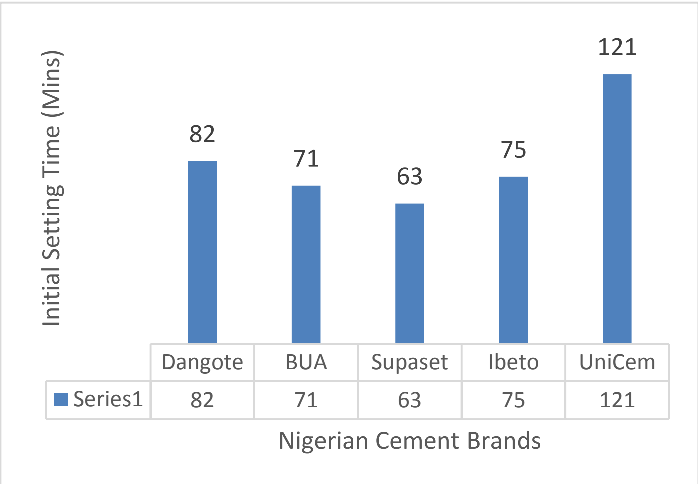


Figure 4: Initial setting time of Nigerian grade 42.5N Portland Limestone cement

The initial setting time obtained for Dangote, BUA, Supaset, Ibeto and UniCem as shown in Figure 4, are 82, 71, 63, 75, and 121 minutes respectively. This is to say that Supaset is the earliest to set initially, while UniCem takes the longest time to set. However, all the cement brands tested had acceptable initial setting times as specified by NIS 444 - 1 (2003).

3.5. Final Setting Time:

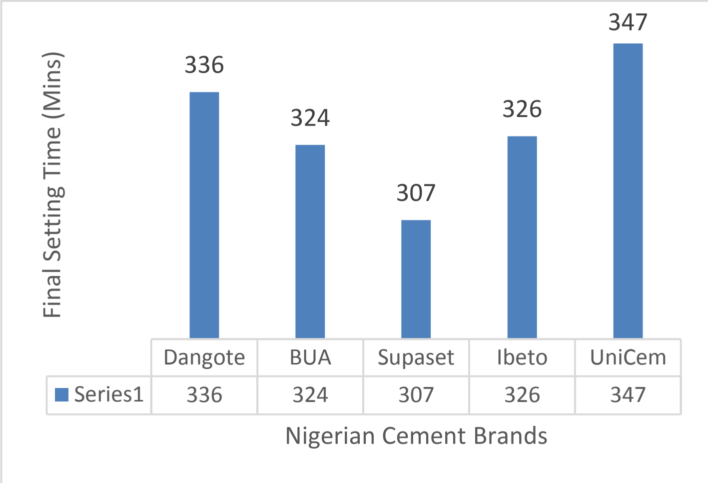


Figure 5: Final setting time of Nigerian grade 42.5N Portland Limestone cement

The Final setting time obtained for Dangote, BUA, Supaset, Ibeto and UniCem as shown in Figure 5, are 336, 324, 307, 326, and 347 minutes respectively. This is to say that Supaset is the earliest to set finally, while UniCem takes the longest time to set. However, all the cement brands tested had acceptable final setting times lower than 600 minutes as specified by [16].

3.6. Soundness/Resistance to Expansion:

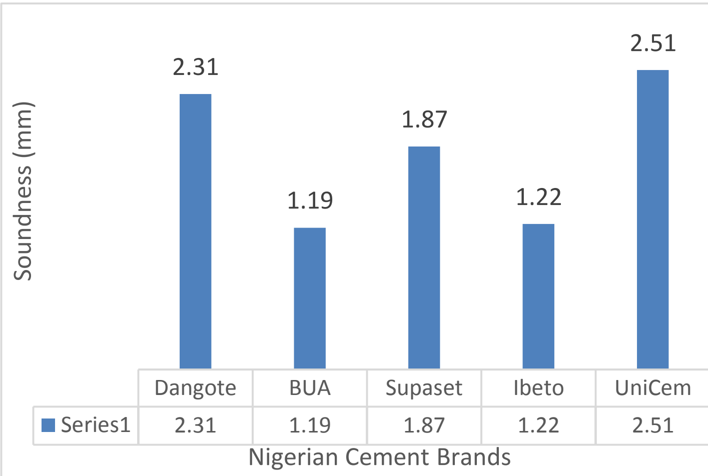


Figure 6: Soundness of Nigerian grade 42.5N Portland Limestone cement

Results on cement soundness and resistance to expansion due to temperature variation at a mix ratio of 1:3 and at a water content of 0.85P (P is the water content required to achieve optimum fluidity or standard consistency) are as shown in Figure 6. The Soundness obtained for Dangote, BUA, Supaset, Ibeto and UniCem are 2.31, 1.19, 1.87, 1.22, and 2.51 mm respectively. This is to say that BUA is the most durable under conditions of changing temperatures, followed by Ibeto, Supaset, Dangote and Unicem. However, all the cement brands tested had acceptable soundness as non was greater than 10mm as specified by [16].

3.7. Fineness:

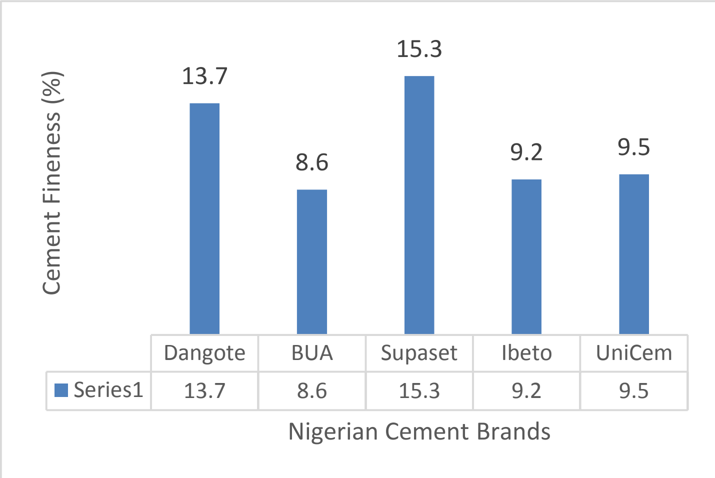


Figure 7: Fineness of Nigerian grade 42.5N Portland Limestone cement

The Fineness obtained for Dangote, BUA, Supaset, Ibeto and UniCem are 13.7, 8.6, 15.3, 9.2, and 9.5 mm respectively. This is to say that BUA has the highest fineness and highest area available for water cement hydration reaction, followed by Ibeto, Unicem, Dangote and Supaset. However, all the cement brands (but Supaset and Dangote) tested had acceptable fineness as specified by [16].

Summary of physical results obtained for the five cement brands are as shown in Table 3;

Table 3: Physical Parameters of PLC Cement Brands in Nigeria

S/N	Physical Parameters of PLC Cement Brands in Nigeria							
		Nigerian Cement Brands					NIS 444 - 1 (2003)	
	Properties	Dangote	BUA	Supaset	Ibeto	UniCem	Min	Max
1	Specific Gravity	2.98	3.13	3.15	2.94	2.88	3.1	3.15
2	Consistency (%)	30.7	27.2	26.3	27.7	31.52	25	30
	Setting Time							
3	Initial Setting time (Mins)	82	71	63	75	121	60	N.S.
4	Final Setting Time (Mins)	336	324	307	326	347	600	N.S.
5	Soundness (mm)	2.31	1.19	1.87	1.22	2.51	N.S.	10
6	Fineness (%)	8.7	4.6	3.7	5.7	6.52	N.S.	10

3.8. Workability of Fresh Concrete Mixes:

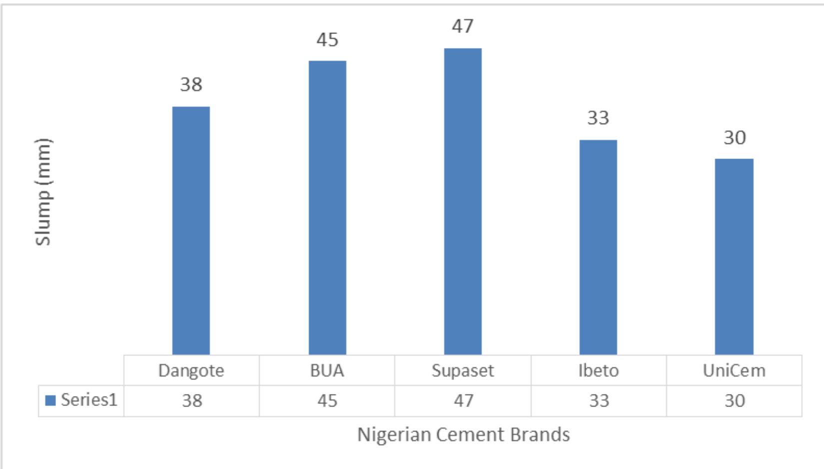


Figure 8: Concrete slump for various brands of Nigerian grade 42.5N Portland Limestone cement

Workabiltiy is essential in concrete mixes to allow for adequate compaction and placing of concrete to achieve its pre-designed shape. At a constant water to cement ratio of 0.55, the slump results obtained for the concrete with various cement brands are as shown in Figure 8. From the results, it is show that Supaset had the highest fluidity, followed by BUA, Dangote, Ibeto and finaly UniCem. It is evident that the relationship between cement fineness and slump is direct to a great degree, such that the finer cement brands tend to yield the most fluid cement concrete mix, which will ultimately reflect in the density and mechanical indices of the concrete.

3.9. Density of Hardened Concrete:

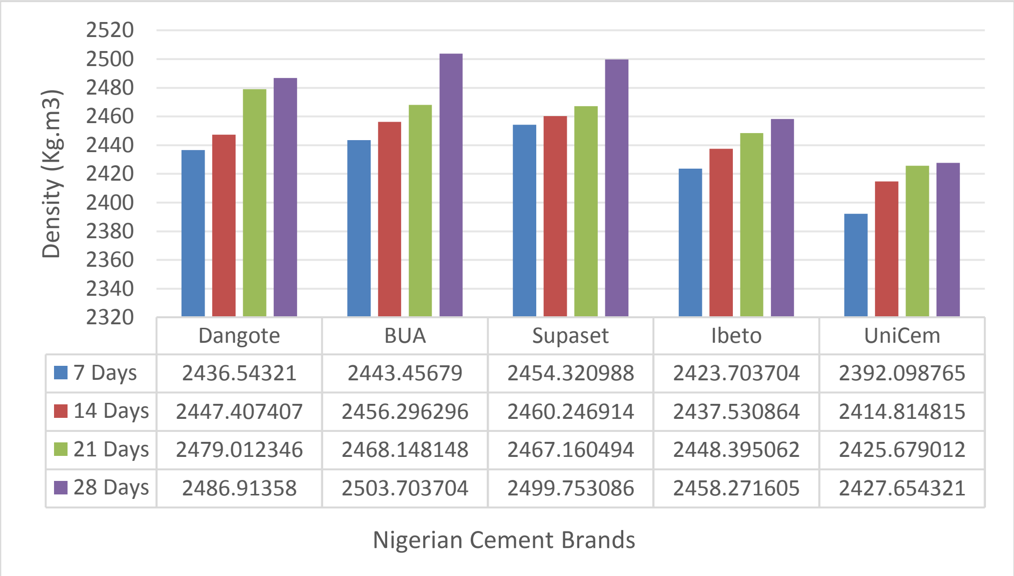


Figure 9: Concrete density for various brands of Nigerian grade 42.5N Portland Limestone cement at varying days

From Figure 9, t is shown that all cement brands yielded concretes with increasing densities relative to curing ages. Dangote cement increased in density from 2436.54 at age 7 to 2486.91 at age 28, which is a 2.07% increment in density; BUA increased from 2443.46 a 7 days to 2503.70 at age 28, a 2.47% increment in density; Supaset, Ibeto and Unicem also increased in densities by 1.85%, 1.42% and 1.48% respectively.

3.10. Compressive Strength of Hardened Concrete:

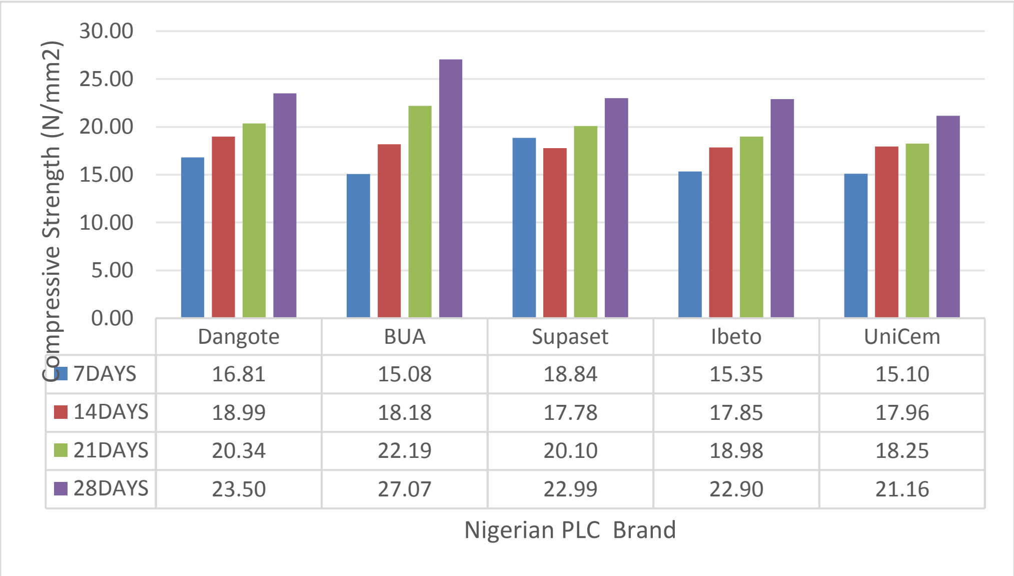


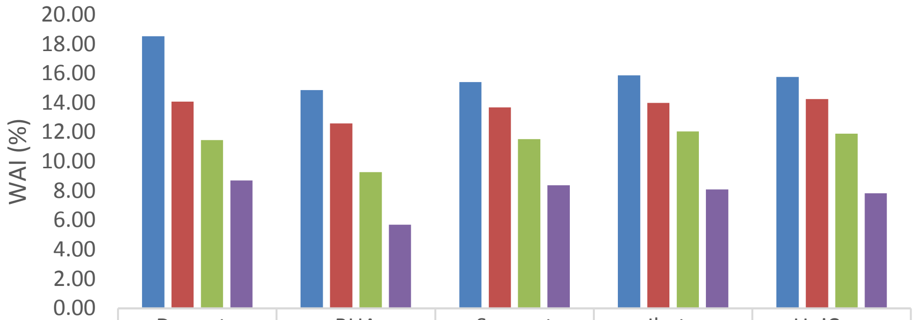
Figure 10: Compressive strength results for Nigerian PLC brands concrete at varying curing ages

From Figure 10, the compressive strength for the concretes different PLC brands is shown. It is observed that the Dangote had the highest compressive strength at the earliest curing age (Day7), however, at 28 days, the increment in strength was the lowest at 39.74%. Additionally, BUA which had the lowest early strength of 15.08N/mm2, increased the highest by 79.47% at ages 28 days. Supaset, Ibeto, and Unicem also had respective percentage increases in strength of 22.01%, 49.23% and 40.14%. Ultimately, all Nigerian PLC brands tested yielded a 28 day result that was greater than the target strength of an M15 grade concrete which is 20.78N/mm^2.

3.11. Water Absorption Index of Hardened Concrete:

Concrete durability is a primary factor that is mostly influenced by the sorptivity or degree of moisture absorption by the concrete. Researchers have specified that for a concrete to be durability, its water absorption index at 28 days, should be below 10%,[26,27,28]. For optimum durability, [28] recommends 4-6% as the ideal water absorption range.

From Figure 11, it is evident that water absorption generally reduces with increases in curing age. At 28 days of curing, all Cement brands yielded a concrete water absorption less than 10%, however, only BUA cement had a water absorption of 5.7% which is less than the maximum specification of 6% by [28].



	Dangote	BUA	Supaset	Ibeto	UniCem
7DAYS	18.52	14.87	15.41	15.86	15.74
14DAYS	14.07	12.58	13.68	13.98	14.25
21DAYS	11.46	9.26	11.52	12.05	11.89
28DAYS	8.70	5.70	8.37	8.08	7.83

Figure 11: Water absorption results for Nigerian PLC brands concrete at varying curing ages

IV. Discussion

Five Nigerian brands of Portland Limestone Cement (PLC) have been investigated, for their compliance with [16] which is the disposition by the Standard Organization of Nigeria (SON) on the composition, specification and conformity criteria for common cements,.

From the physical results obtained, Dangote, Ibeto and Unicem had specific gravities outside the specified range of 3.1 - 3.15; Dangote, and UniCem had consistencies outside the specified range of 25 - 30%; All cement brands conformed with the specifications for initial and final setting times; All cement brands conformed with the specifications for soundness; Dangote and Supaset did not conform to the specifications for Fineness.

From the Compressive strength analysis, all cement brands had compressive strength conforming with the minimum requirement for a grade M15 concrete, such that their target strength was above 20.78 N/mm^2

The 4 - 6% water absorption specification by [28], was satisfied by only BUA concretes, while all other brands had sorptivities less than 10%.

V. Conclusion

From the results obtained from this study, we hereby conclude that cement fineness plays critical role in the cements contribution to concrete strength and durability. We recommend that SON in lieu of enhanced quality control and quality assurance in the Nigerian cement industry, conducts periodic inspection to ensure compliance with [16]. This is most necessary for concrete structures with continuous immersion in water, seeing the physical parameters such as fineness plays a critical role in the sorptivity and strength of the concrete.

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