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Comparative Analysis of Compressive Strength of Concrete Produced Using Course Aggregates from Selected Locations in Imo State, Nigeria

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Abstract
This study aims to compare the compressive strength of concrete produced from locally sourced coarse aggregates in Imo State and with a view to determine their suitability for construction. Objectives is to discuss and characterize the coarse aggregates found within the study area, to determine the compressive strength of concrete produced using these aggregates, identify the factors affecting the compressive strength of concrete produced within the study area. In achieving this, experiments conducted were the sieve analysis, specific gravity and water absorption test, slump test and compressive strength test. The sieve analysis result shows that, when sieve sizes of 20, 12.5, 10, 4.75, 2.36 and 1.25 were used, the cumulative percentage weight retained for the coarse aggregates obtained in Obinze, Okigwe and Njaba were; 0, 2.11, 39.36, 79.65, 97.48, 100 percent; 0, 0.059, 32.26, 82.92, 97.7 and 0, 0.91, 33.61, 82.34, 97.98, 100% respectively. Result obtained from the specific gravity and water absorption tests shows that the average specific gravity and average water absorption rate of coarse aggregates obtained from Obinze, Okigwe, Njaba are 2.80 and 0.57%; 2.76 and 0.55%; 2.78 and 0.69% respectively, which is between 2.5- 3 specific gravity, and with water absorption rate less than 3%. Result of the slump test showed that the slump values of concrete produced using Obinze stone, Okigwe stone and Njaba stone are 66mm, 81.5mm and 77mm respectively, which is within 50-100mm (medium) degree of workability. Result from the compressive strength of concrete shows that the average compressive strength of concrete produced using coarse aggregate from Obinze, Okigwe and Njaba, at 3days, 14days, 21days and 28days were as follows; 17.26 N/mm^2, 19.04 N/mm^2, 26.96 N/mm^2 and 29.26 N/mm^2 for Obinze aggregates, 16.59 N/mm^2, 18.81 N/mm^2, 22.30 N/mm^2 and 25.85N/mm^2 for Okigwe aggregate and 17.26 N/mm^2, 21.72 N/mm^2, 23.73 N/mm^2 and 26.30 $N/mm^2$for Njaba Aggregate. The hypothesis was tested with ANOVA method at a 5% significant level to test for the variation among the compressive strength of concrete produced from the selected locations in Imo state. The study concludes that there is no significant variation in the compressive strength of concretes produced from coarse aggregates obtained from selected locations in Imo in a ratio of 1:2:4 and were all above 25N/mm^2 at 28 days of curing which exceeds the minimum required compressive strength for M25 grade targeted. The Okigwe gravel of Okigwe local government area performed best with a compressive strength of 29.26N/mm^2 after 28days of curing. Followed by the Njaba aggregates with a compressive strength of 26.30N/mm^2 and then the least performed was the Obinze gravel with compressive strength of 25.85N/mm^2 after 28days of curing. The study recommends Okigwe gravel for standard concrete grade design of between 25 and 29N/mm^2. Although the concrete made from the other two aggregates were above 25N/mm^2 which could be attributed to adequate curing in the concrete lab and which may not be available on in-situ concrete.

Keywords: Coarse Aggregate, Concrete Test

1. Introduction

Concrete, a fundamental construction material, is a composite of cement, fine aggregate (sand), coarse aggregate (gravel or crushed stone), and water, combined in specific proportions (Ajagbe, Tijani, and Agbede, 2018) [6]. Defined as an artificial stone-like material, concrete is valued for its high compressive strength and fire resistance (Oyenuga, 2001; Ede & Aina, 2015; Raheem & Bamigboye, 2013) [102, 29, 108].

However, compromised standards or insufficient understanding of factors influencing compressive strength can lead to structural weaknesses. Aggregates, essential components of concrete, are granular materials like sand, gravel, or crushed stone, utilized in various civil engineering applications (Kamran, Mohammad, and Konstantinos, 2015; Kosmatka and Wilson, 2016; Lesovik *et al*. 2021) [62, 66]. Classified as fine (typically < 5mm) and coarse (generally 9.5mm to 37.5mm), aggregates constitute a significant portion (around 75%) of concrete volume, with coarse aggregates contributing 50-60% depending on the mix ratio (Waziri, Bukar, and Gaji, 2011; Kosmatka & Wilson, 2016) [126]. Changes in coarse aggregate characteristics directly impact concrete's compressive strength and fracture properties (Ajagbe, Tijani, and Agbede, 2018) [6]. Compressive strength, a critical measure of concrete's load-bearing capacity, is assessed through compression testing (Ajagbe, Tijani, and Agbede, 2018) [6]. The prevalence of substandard materials, particularly concrete, is a major contributor to building collapses in Nigeria (Ayininuola and Olalusi, 2004; Ede, 2010, 2011) [16, 29]. Concrete strength is significantly influenced by the water-cement ratio, while workability is affected by the aggregate-water ratio, and cost by the aggregate-cement ratio (Deodhar, 2009) [27]. Research indicates that aggregate type is a crucial factor influencing concrete strength (Ezeldin and Aitcin, 1991) [32]. Studies have shown that in high-strength concrete, stronger coarse aggregates lead to higher compressive strengths, whereas in normal-strength concrete, the effect is less pronounced. Given the variability in coarse aggregate properties due to location, understanding their impact on concrete behavior under loading is essential. Therefore, testing concrete produced with aggregates from diverse locations is crucial to determine their influence on compressive strength and ensure structural integrity.

2. Methods

This study employed a mixed research design, integrating both quantitative and qualitative data collection and analysis, to comprehensively address the research hypothesis, aim, and objectives. Specifically, an experimental research design was utilized to achieve objectives related to determining aggregate characteristics, compressive strength, and comparative strength analyses (Research Objectives). This design allowed for controlled, practical investigation of the variables. To address objective iii, which focused on identifying parameters influencing compressive strength, an exploratory survey research design was adopted. This approach facilitated the exploration and illumination of existing phenomena related to concrete production in the study area. The combination of these designs ensured a robust and multifaceted investigation, leveraging the strengths of both experimental and exploratory methods. The procedure for this study is as follows:

1. Problem formulation

Despite the dominance of concrete in Nigerian construction, a significant proportion of structural failures involve this material (Alam *et al*. 2016) [8]. The quality of building materials, particularly coarse aggregates, is a critical factor influencing the performance of the construction industry (Ugochukwu, Ogbuagu, and Okechukwu, 2014). Degradation in aggregate quality jeopardizes structural integrity, posing risks to life, property, and the economy. As coarse aggregates constitute 50-60% of concrete volume and are a primary source of strength, their quality is paramount (Bamigboye, Edeh, Umana, Odewumi, and Olowu, 2016). The use of poorly graded aggregates results in voids and weak bonds, compromising the concrete's ability to withstand loads and leading to potential structural failure (Belay, 2021). Research has consistently highlighted aggregates, along with cement, mixing, and placement, as key determinants of concrete strength (Shetty, 2006; Zongjin, 2011; Ede *et al*. 2015) [134, 29]. Study by Onyechere, Ezeriaku, Anya and Nwachukwu (2020) examined compressive strength of concrete made from three different coarse aggregates namely; rivers gravel, crushed granites and sand stone sourced from South Eastern Nigeria. The crushed granite was sourced from Asphalt and Unity Company (AUC) Nig. Ltd. Quarry site of igneous rock at Ishiagu, Ebonyi State; the rivers gravel was gotten from Awgu, a river located around Enugu state. And the Sand stone sourced from Enugu Ezikein in Enugu state. In their study, concrete made using crushed granite with a mix ratio of 1:1.5:4.5 gave the highest compressive strength of 22N/mm^{2}at 28days of curing when compared with concrete made with other aggregates and recommended that crushed granite should be used in construction of load bearing structures. However, the cost of purchasing and transporting the conventional crushed granite is quite high compared to the locally sourced coarse aggregates. This study compared the compressive strength of concrete produced using different coarse aggregates obtained from some selected locations in Imo State. Noteworthy, no attention was given to the analysis of compressive strength of concrete produced using coarse aggregates obtained locally in Imo state from the previous study even though Imo is part of the South Eastern part of Nigeria. Therefore, by deducing this study to Imo state, more insight was provided. Moreover, Imo state is rich in sand stone also known as surface stone.

2. Literature search

There are various experimental studies conducted on determining the compressive strength of concrete using alternative coarse aggregates in place of granite. (Okafor, 2010) carried out a study to determination of the compressive and flexural strength of concrete produced from three concrete mixes of widely differing water cement ratios made using crushed waste concrete as coarse aggregate. The physical properties of the recycled aggregate, the compressive and flexural strengths of the concrete were the properties investigated. These properties were compared with similar concrete specimens made with conventional natural aggregate. The compressive strength of concrete cubes cut from the waste concrete was also tested. Tests result showed that the strength of concrete made from recycled waste concrete aggregate is dependent on the strength of the original strength of the concrete from which the recycled aggregate is derived. In conclusion, he stated that the recycled aggregate may be used to produce quality concrete only when the strength of concrete required is not greater than the strength of the original concrete from which the recycled aggregate was made from. Alli, Odewumi, and Alli (2018) [11] also carried a study on the Comparative Analysis of Strength and Physical Properties of Concrete Made from Three Different Coarse Aggregate (Granite, Gravel and Palm Kernel) with the aim of examining the comparative analysis of the strength and physical properties of concrete made from three different coarse aggregates. Sieve analysis and compressive test were conducted using a 150mm×150mm×150mm mold and a mix ratio of 1:2:4 by weight of concrete and water cement ratio of 0.5 was adopted, 36 cubes were produced and all the samples were cured in fresh water pond. The compressive strength of the concrete cubes at 7, 14, 21 and 28 days were noted. It was observed from the result of the compressive strength that the different coarse aggregate used, possess different compressive strength value. The mean strength in N/mm2 of concrete cubes cast with palm kernel at 7, 14,21and 28days gave 3.64N/mm^2, 3.82N/mm^2 4.00N/mm^2 and 4.22N/mm^2 respectively while concrete made of gravel gave strength of 12.53 N/mm^2, 12.98 N/mm^2, 13.33 N/mm^2, 16.67 N/mm^2, For concrete made of granite, the strength are 14.53 N/mm^2, 15.56 N/mm^2, 18.67 N/mm^2 and 20.44 N/mm^2 respectively. The study concludes that, the compressive strength of concrete made from granite gave higher compressive strength value of 20.44 N/mm2, at 28days as compared to the compressive strength of concrete made of gravel and palm kernel shell which gave a compressive strength value of 16.67 N/mm^2 and 4.0N/mm^2 respectively. Study by Nwokoye and Ezeagu (2016) [86] on optimization of the strength of concrete Made from Nigerian processed aggregate which aim is to optimize the strength of concrete produced with concrete made from Nigeria processed aggregate. Comparisons were made of the various properties of concrete made of crushed rock aggregates from six (6) sites in two different locations; three (3) samples each from Abakaliki in Ebonyi state and Auchi in Delta state Nigeria respectively. The properties compared include workability, bulk density, specific gravity and strength to enable the determination and comparison of their compressive strengths. Aggregates of 20mm size were employed in the investigation. The mix ratio and water/cement ratio adopted for the study were 1:2:4 and 0.5 respectively. A total of forty-eight(48) concrete cubes (150mm x 150mm x 150mm) were casted of which two (2) cubes were crushed for each sample aggregate at each maturity age namely; 7, 14, 21, and 28 days. All cubes reached the target mean strength after 7 days of curing. The 28 days strengths of the concretes on the average of two locations were 25.67N/mm2 and 22.07N/mm2. Consequently, the study concluded that the strength of concrete depends greatly on the specific gravity of crushed stones as well as the weight of concrete.

3. Data evaluation

The objectives of this study are as follows:

1. To discuss and characterize the coarse aggregates found within the study area
2. To determine the compressive strength of concrete produced using these aggregates;
3. Identify the factors affecting the compressive strength of concrete produced within the study area
4. Compare the strength development of the concrete over 3, 14, 21, and 28 days of curing with that of required standard

4. Data analysis and interpretation

The data analysis technique used by the author is the content analysis technique where the author will analyze the results of research that has been carried out based on suitability with the topic discussed and the time of implementation of the research. Data addressing the objective 1 which was to determine the nature and characteristics of the coarse aggregates obtained in Imo State was achieved through conducting gradation test (Sieve analysis), Specific Gravity and water absorption test and Slump test. Data obtained from these tests were calculated to determine the grade of coarse aggregate, specific gravity and water absorption rate, and the slump value respectively. From the result of this tests,

A. When the gradation varies, it implies proper bonding

B. The standard specific gravity of normal coarse aggregates falls between 2.5 – 3 C. Water absorption rate for normal coarse aggregate is generally restricted by less than 3% (Kim *et al*, 2020)

d. Slump value of 0-50, 50-100, and 100 – 150 represents low, medium, and high workability of concrete respectively.

Data for objective 2 which is to determine the compressive strength of concrete produced with coarse aggregates from Imo, was obtained from the crushing of the concrete and was calculated to arrive at the compressive strength of the concrete. The measured compressive strength of the cubes was calculated by dividing the maximum load applied to the cubes during the test by the cross-sectional area, calculated from the mean dimensions of the section and was expressed to the nearest 0.5 N/mm^2.

Data addressing objective 3 which is to compare the strength of concrete made from coarse aggregates obtained in Imo at 7th,14th,21st and 28th days old of concrete was obtained from the result of the compression test conducted at the Civil Engineering laboratory Federal Polytechnic Nekede, Owerri, Imo State.

Data addressing objective 4wascollected based on the construction professionals' perception on parameters influencing compressive strength of concrete. The data on these objectives was collected on five-point Likert scale as follows: scale 1 = strongly disagree; 2 =disagree; 3 = uncertain; 4 = agree; 5 = strongly agree. The ordinal data collected for objectives four was analyzed to obtain the mean item score (MIS) of each of the parameters. The decision for accepting any of the identified variables as an influential factor to the compressive strength of concrete is based on the weighted mean of '3'; The MIS ≥ 3.00 was considered as important parameter.

ANOVA test was used at 5% significant level to test for significant variation among the compressive strength of concrete produced using coarse aggregate obtained from different locations in Imo state. The decision rule was that, if P-value is less than or equal to 0.05 ($P \leq 0.05$), the null hypothesis will be rejected giving preference to the alternative. But if the P-value is greater than 0.05 ($P> 0.05$), the null hypothesis will be accepted while the alternative hypothesis will not be considered.

3. Results and Discussion

Table 1: Sieve Analysis for Obinze Gravel.

B.S sieve sizes	Weight retained (g)	Percentage Weight retained (%)	Cumulative % weight retained	Cumulative % weight passing
20	0	0	0	100
12.5	32	2.11	2.11	97.89
10	564	37.25	39.36	60.64
4.75	610	40.29	79.65	20.35
2.36	270	17.83	97.48	2.52
1.25	38	2.52	100	0
Total	1514	100%		

***Source*:** Researcher's Experimental Data (2025).

Table 2: Sieve Analysis for Okigwe Gravel

B.S sieve sizes	Weight retained (g)	Percentage Weight retained (%)	Cumulative % weight retained	Cumulative % weight passing
20	0	0	0	100
12.5	9	0.59	0.59	99.41
10	482	31.67	32.26	67.74
4.75	771	50.66	82.92	17.08
2.36	225	14.78	97.7	2.30
1.25	35	2.3	100	0.00
Total	1522	100%		

***Source*:** Researcher's Experimental Data (2025).

Table 3: Sieve Analysis for Njaba Gravel

B.S sieve sizes	Weight retained (g)	Percentage Weight retained (%)	Cumulative % weight retained	Cumulative % weight passing
20	0	0	0	100
12.5	14	0.91	0.91	99.09
10	502	32.70	33.61	66.39
4.75	748	48.73	82.34	17.66
2.36	240	15.64	97.98	2.02
1.25	31	2.02	100	0.00
Total	1535	100%		

Source: Researcher's Experimental Data (2025).

Table 4: specific gravity and water absorption test for coarse aggregate obtained from Obinze gravel at Owerri West LGA. Imo State.

S/n	Description	Sample 1	Sample 2	Sample 3	Average
1.	Weight of saturated sample aggregate suspended in water W1	1602.5	1599.5	1599.5	1600.50
2.	Weight of saturated sample aggregate in the air W2	2484	2480	2,483	2,482.33
3.	Weight of oven dried aggregate in the air W3	2470	2466	2469	2468.33
4.	Specific gravity = W3/(W2-W1)	2.80	2.80	2.79	2.80
5	Apparent Specific gravity = W3/ (W3-W1)	2.85	2.85	2.84	2.85
6	Water Absorption = (W2-W3/ W3) X 100	0.57%	0.57%	0.57%	0.57%

***Source*:** Researcher's Experimental Data (2025).

Table 5: specific gravity and water absorption test for coarse aggregate obtained from Okigwe in Okigwe LGA, Imo State

S/n	Description	Sample 1	Sample 2	Sample 3	Average
1.	Weight of saturated sample aggregate suspended in water W1	1555	1558.5	1551.5	1555
2.	Weight of saturated sample aggregate in the air W2	2432	2436	2429.5	2,932.5
3.	Weight of oven dried aggregate in the air W3	2419	2420.5	2418	2419.17
4.	Specific gravity = W3/(W2-W1)	2.76	2.76	2.75	2.76
5	Apparent Specific gravity = W3/ (W3-W1)	2.80	2.81	2.79	2.80
6	Water Absorption = (W2-W3/ W3) X 100	0.54%	0.64%	0.48%	0.55%

***Source*:** Researcher's Experimental Data (2025).

Table 6: specific gravity and water absorption test for coarse aggregate obtained from Njaba, Orlu, LGA, Imo State

S/n	Description	Sample 1	Sample 2	Sample 3	Average
1.	Weight of saturated sample aggregate suspended in water W1	1578	1562	1568	1569.33
2.	Weight of saturated sample aggregate in the air W2	2452	2437.2	2443	2444.1
3.	Weight of oven dried aggregate in the air W3	2431	2420.5	2430.5	2427.33
4.	Specific gravity = W3/(W2-W1)	2.78	2.77	2.78	2.78
5	Apparent Specific gravity = W3/ (W3-W1)	2.85	2.82	2.82	2.83
6	Water Absorption = (W2-W3/ W3) X 100	0.86%	0.69%	0.51%	0.69%

***Source*:** Researcher's Experimental Data (2025).

Table 7: Compressive Strength Test Result of Concrete Produced using Coarse Aggregate Obtained from Obinze, Owerri West LGA Imo State.

Durations (days)	Cube reference	Mass (kg)	Density kg/m^3(v = 3.38 x 10^{-3})	Average density kg/m^3	Cross section area (mm^2)	Crushing Load (N)	Stress (N/mm^2)	Average Stress (N/mm^2)
3 days	AW1A	7.42	2,195.27	2207.10	22500.00	360 X 10^3	16.00	17.26
	AW1B	7.56	2,236.69		22500.00	400 X 10^3	17.78	
	AW1C	7.40	2,189.35		22500.00	405 X 10^3	18.00	
14 days	AW2A	8.52	2520.71	2575.94	22500.00	420 x 10^3	18.67	19.04
	AW2B	8.77	2594.67		22500.00	435 x 10^3	19.33	
	AW2C	8.83	2,612.43		22500.00	430 x 10^3	19.11	
21 days	AW3A	8.40	2,485.21	2507.89	22500.00	590 x 10^3	26.22	26.96
	AW3B	8.32	2,461.54		22500.00	610 x 10^3	27.11	
	AW3C	8.71	2,576.92		22500.00	620 x 10^3	27.56	
28 days	AW4A	8.50	2,514.79	2492.11	22500.00	650 x 10^3	28.89	29.26
	AW4B	8.54	2,526.63		22500.00	665 x 10^3	29.56	
	AW4C	8.23	2,434.91		22500.00	660 x 10^3	29.33	

Source: Researcher's Experimental Data (2025).

Table 8: Compressive Strength test result of concrete produced using coarse aggregate obtained from Okigwe, Okigwe LGA Imo State.

Durations (days)	Cube reference	Mass (kg)	Density kg/m^3 (v = 3.38 x 10^{-3})	Average density kg/m^3	Cross section area (mm^2)	Crushing Load (N)	Stress (N/mm^2)	Average Stress (N/mm^2)
3days	EE1A	6.88	2,035.50	1984.22	22500	365 x 10^3	16.22	16.59
	EE1B	6.67	1,973.37		22500	380 x 10^3	16.89	
	EE 2C	6.57	1,943.79		22500	375 x 10^3	16.67	
14 days	EE2A	8.48	2,508.88	2499.01	22500	425 x 10^3	18.89	18.81
	EE2B	8.37	2,476.33		22500	410 x 10^3	18.22	
	EE2C	8.49	2,511.83		22500	435 x 10^3	19.33	
21 days	EE3A	8.75	2,588.76	2521.70	22500	490 x 10^3	21.78	22.30
	EE3B	8.25	2,440.83		22500	510 x 10^3	22.67	
	EE3C	8.57	2,535.50		22500	505 x 10^3	22.44	
28 days	EE4A	8.71	2,576.92	2,590.70	22500	570 x 10^3	25.33	25.85
	EE4B	8.90	2633.14		22500	585 x 10^3	26.00	
	EE4C	8.66	2562.13		22500	590 x 10^3	26.22	

***Source*:** Researcher's Experimental Data (2025).

Table 9: Compressive Strength test Result of Concrete Produced using coarse aggregate Obtained from Njaba in Orlu LGA Imo State.

Durations (days)	Cube reference	Mass (kg)	Density kg/m^3 (v = 3.38 x 10^{-3})	Average density kg/m^3	Cross section area (mm^2)	Crushing Load (N)	Stress (N/mm^2)	Average Stress (N/mm^2)
3 days	UG1A	7.20	230.18	2145.96	22500.00	370 x 10^3	16.44	17.26
	UG1B	7.26	2147.93		22500.00	400 x 10^3	17.78	
	UG1C	7.30	2159.76		22500.00	395 X 10^3	17.56	
14 days	UG2A	8.23	2434.91	2,515.78	22500.00	480 x 10^3	21.35	21.72
	UG2B	8.52	2520.71		22500.00	496 x 10^3	22.04	
	UG2C	8.76	2591.72		22500.00	490 x 10^3	21.78	
21 days	UG3A	8.40	2485. 21	2544.87	22500.00	545 x 10^3	24.22	23.73
	UG3B	8.65	2557.69		22500.00	535 x 10^3	23.78	
	UG3C	8.76	2591.72		22500.00	522 x 10^3	26.20	
28 days	UG4A	8.56	2532.54	2503.94	22500.00	592 x 10^3	26.31	26.30
	UG4B	8.48	2508.88		22500.00	594 x 10^3	26.40	
	UG4C	8.35	2470.41		22500.00	589 x 10^3	26.18	

***Source*:** Researcher's Experimental Data (2025).

Table 10: Perception of Selected Construction Professionals on Parameters Influencing Compressive Strength of Concrete Produced in Imo.

Parameters Influencing compressive strength of concrete	Architects N= 93			Builders N =24			Engineers N = 89			Combined N = 206		
	Sum	mean	Rank	sum	mean	Rank	Sum	mean	rank	Sum	Mean	rank
Aggregate size	349	3.75	7	92	3.83	7	344	3.87	7	785	3.81	7
Alkali reactivity rate	337	3.62	8	85	3.54	10	315	3.54	9	737	3.58	8
Aggregate shape	318	3.42	13	75	3.13	16	303	3.40	13	696	3.38	12
Soundness of particles	326	3.51	12	81	3.38	13	312	3.51	10	719	3.49	10
Degree of hydration	383	4.12	5	95	3.96	5	349	3.92	6	827	4.01	5
Presents of salt	331	3.56	10	87	3.63	8	319	3.58	8	737	3.58	8
Presence of organic impurity	327	3.52	11	83	3.46	11	304	3.42	12	714	3.47	11
Presence of clay	332	3.57	9	82	3.42	12	308	3.46	11	722	3.50	9
Curing	398	4.28	3	110	4.58	1	377	4.24	2	885	4.30	2
Source of aggregate	297	3.19	16	77	3.21	15	294	3.30	15	668	3.24	14

Mix proportion	409	4.40	2	108	4.50	2	380	4.27	1	897	4.35	1
Water cement ratio	391	4.20	4	94	3.92	6	368	4.13	3	853	4.14	4
Type of aggregate used	311	3.34	14	86	3.58	9	299	3.36	14	696	3.38	12
Type/ brand of cement	301	3.24	15	74	3.08	17	280	3.15	17	655	3.18	15
Age of concrete	367	3.95	6	99	4.13	3	355	3.99	5	821	3.99	6
Fineness of cement used	301	3.24	13	79	3.29	14	290	3.26	16	670	3.25	13
Presence of deleterious substance	413	4.44	1	98	4.08	4	363	4.08	4	874	4.24	3
Group Mean		3.73			3.69			3.68			3.49	

***Source*:** Researcher's filed Data (2025).

Table 11: One Way ANOVA test to determine if Significant Variation exist in the Compressive Strength of Concrete Produced using Coarse Aggregate Obtained in Different Location in Imo State.

ANOVA					
Compressive strength of concrete	**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	10.216	2	5.108	.234	.796
Within Groups	196.611	9	21.846		
Total	206.827	11			

***Source*:** Researcher's field Data (2025).

4. Discussion

1. In summary, from the researcher's direct observation of sources of coarse aggregate in Imo state, this two-source noted are the rivers and borrow source. But the borrow source is the main source in the study area.
2. In other to determine the nature and characteristics of the coarse aggregates obtained in the study area, sieve analysis, specific density and water absorption test, and slump test were conducted. The result obtained in Table 4.2, 4.3 and 4.4 shows that when sieves sizes ranging from 20, 12.5, 10, 4.75, 2.36 and 1.25 were used to conduct sieve analysis test using coarse aggregate obtained in Obinze, Okigwe and Njaba, the cumulative % weight retained are; 0, 2.11, 39.36, 79.65, 97.48 and 100 percent respectively and cumulative % weight passing are 100, 97.89, 60.64, 20.35, 2.52 and 0 percent respectively for Obinze Stones obtained in Owerri West LGA. For coarse aggregate obtained from Okigwe, the cumulative % weight retained are 0, 0.059, 32.26, 82.92, 97.7 and 100% respectively, while the cumulative % weight passing are 100, 99.41, 67.74, 17.08, 2.30 and 0.00 respectively. For Coarse aggregate obtained from Njaba, the cumulative % weight retained are 0, 0.91, 33.61, 82.34, 97.98 and 100% respectively, and the cumulative % weight passing are 100, 99.09, 66.39, 17.66, 2.02 and 0.00 respectively. Also, The Figure 4.1 which is a graphical presentation of the gradation curve, shows changes in the curves as the sizes of the aggregates changes in-line with the sieve sizes.
3. Furthermore, Table 4.5, 4.6 and 4.7 shows that the average specific gravity and average water absorption rate of coarse aggregates obtained from Obinze in Owerri West LGA, Okigwe in Okigwe LGA., Njaba in Orlu LGA are; 2.80 and 0.57%, 2.76 and 0.55%, and 2.78 and 0.69% respectively. which is between 2.5- 3 and the water absorption rate is also less than 3% as posited by Kim *et al.*, (2020) for normal coarse aggregate.
4. Further still, Table 4.8 shows that the slump values of concrete produced using Obinze stone, Okigwe stone and Njaba stone are 66mm, 81.5mm and 77mm respectively. This implies that the concrete produced using Okigwe stone has the highest slump value. Followed by the once produced using stones obtained from Njaba. Lastly, those produced using stones from Obinze became third. Also, following IS 456:2000, the average slump test for concrete produced from the three locations falls within the "medium" degree of workability as the IS 456:2000 shows that slump test value in the range of 50mm – 100mm has medium degree of workability. Also, the Figure 4.2 shows which is the bar chart presentation of the slump test result shows that the concrete produced using coarse aggregate obtained from Okigwe has the highest slump value above 80mm, followed by the concrete produced using coarse aggregates from Njaba which has slump value above 75mm but not up to 80mm. Then the concrete produced using coarse aggregate obtained from Obinze has slump value above 65mm but not up to 70mm.
5. More so, to determine the compressive strength of concrete produced in Imo state, a compressive strength test was conducted. The Table 4.9, 4.10 and 4.11 shows the average compressive strength of the concrete produced using coarse aggregate from Obinze in Owerri West LGA Imo State, Okigwe in Okigwe LGA, and Njaba, Orlu LGA for the age of 3days, 14days, 21days, and 28days as; 17.26, 19.04, 26.96, and 29.26 respectively for Obinze Stone; 16.59, 18.81, 22.30 and 25.85N/mm^{2}respectively for Okigwe stone and; 17.26, 21.72, 23.73 and 26.30 N/mm^{2}respectively for Njaba stone.
6. Also, to determine if significant variation exist in the compressive strength of concrete produced using the three selected stones from the study area, ANOVA Test was conducted to obtain the P-value. The Table 4.12 shows that the P-value of ANOVA H-test is 0.796 which is greater than 0.05. Therefore, the null hypothesis (H0) which states that there is no significant variation in the compressive strength of concrete produced using coarse aggregate obtained from different locations in Imo state was accepted in preference to its alternative hypothesis.
7. Finally, in other to establish parameters influencing compressive strength of concrete produced using coarse aggregates obtained from the study area, The Table 4.6 shows that the Group Mean at the Architects, Builders, Engineers and the combined columns is 3.73, 3.69, 3.68 and 3.49 respectively. This result showed that the group means are greater than the weighted mean '3'. Also, the Table 4.6 shows that the mean of all the variables are greater than the weighted mean '3' Which implies that the construction professionals accepted that all the identified variables influences the compressive strength of concrete, though at varying ranks; the Architects

considered “presence of deleterious substances” as the most influential variable to compressive strength of concrete. Thus, it was ranked first among others, followed by “mix proportion”, “Curing”, “Water cement ratio” which ranked second to fourth respectively among other variables. The builders perceived “curing” as the major factor influencing the compressive strength of concrete thus, it ranked first. Followed by “mix proportion”, “Age of Concrete”, “Presence of deleterious substances” which ranked from second to fourth respectively. The Engineers viewed “Mix proportion” as the most influential variable to compressive strength of concrete, thus it ranked first among others. followed by, “curing”, “water cement ratio”, “presence of deleterious substances” which ranked from second to fourth respectively among others. The combined column which represents the combined perspectives of the respondents showed that the construction professionals generally viewed “Mix proportion” as the most influential variable to compressive strength of concrete thus it ranked first. Followed by “curing”, “presence of deleterious substances”, “water cement ratio” which ranked from second to fourth respectively among other variables.

5. Conclusion

From the result obtained in this study, it was concluded that the sources of coarse aggregates in Imo State are, the rivers and borrow source. But the borrow source predominates the study area.

Also, on determining the nature and characteristics of coarse aggregate obtained from different location in Imo State, this study concluded that when sieves sizes ranging from 20, 12.5, 10, 4.75, 2.36 and 1.25 were used to conduct sieve analysis test using coarse aggregate obtained in Obinze, Okigwe and Njaba, the cumulative % weight retained are; 0, 2.11, 39.36, 79.65, 97.48 and 100 percent respectively and cumulative % weight passing are 100, 97.89, 60.64, 20.35, 2.52 and 0 percent respectively for Obinze Stones obtained in Owerri West LGA. For coarse aggregate obtained from Okigwe, the cumulative % weight retained are 0, 0.059, 32.26, 82.92, 97.7 and 100% respectively, while the cumulative % weight passing are 100, 99.41, 67.74, 17.08, 2.30 and 0.00 respectively. For Coarse aggregate obtained from Njaba, the cumulative % weight retained are 0, 0.91, 33.61, 82.34, 97.98 and 100% respectively, and the cumulative % weight passing are 100, 99.09, 66.39, 17.66, 2.02 and 0.00 respectively. Also, The Figure 4.1 which is a graphical presentation of the gradation curve, shows changes in the curves as the sizes of the aggregates changes in-line with the sieve sizes. This variation curve shows that there is proper bonding of the aggregates.

This study also concludes that the average specific gravity and water absorption rate of coarse aggregates obtained from Obinze, Owerri West LGA, Okigwe in Okigwe LGA., Njaba in Orlu LGA which are; 2.80 and 0.57%, 2.76 and 0.55%, and 2.78 and 0.69% respectively indicates normal coarse aggregate as the specific gravities are between 2.5- 3 and the water absorption rates are less than 3% as posited by Kim *et al.* (2020).

This study further concludes that the slump values of concrete produced using Obinze stone, Okigwe stone and Njaba stone are 66mm, 81.5mm and 77mm respectively, and falls within the 50-100mm slump value which shows a medium slump.

On determining the compressive strength of concrete produced using Obinze stone, Okigwe stone and Njaba stone for age of 3days, 14days, 21days, and 28days, this study concludes that the compressive strength of concrete produced using stones obtained from the aforementioned locations in Imo state are; 17.26, 19.04, 26.96, and 29.26 respectively for Obinze Stone; 16.59, 18.81, 22.30 and 25.85N/mm^2 respectively for Okigwe stone and; 17.26, 21.72, 23.73 and 26.30 N/mm^2 respectively for Njaba stone. However, at the 28th day, none of the concrete yielded a compressive strength that is less than 25N/mm^2 which implies that the coarse aggregates are normal. Also, ANOVA H test to determine if significant variation exist in the compressive strength of the concretes produced using stones obtained from the three selected locations in Imo showed that the P-value is 0.794 which is greater than 0.05. Therefore, this study concludes that there is no statistically significant variation in the compressive strength of concrete produced using stones obtained from the three selected locations in Imo State.

Finally, on establishing the parameters influencing the compressive strength of concrete produced in Imo State, this study concludes that the identified variables in literature are capable of influencing the compressive strength of concrete as the Group Mean at the Architects, Builders, Engineers and the combined columns is 3.73, 3.69, 3.68 and 3.49 respectively which are greater than the weighted mean ‘3’. Also, none of the variables weighed below the weighted mean of ‘3’.

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