IPS Journal of Engineering and Technology
IPS J. Engr. & Tech., 3(1): 21-27 (2025)
DOI: https://doi.org/10.54117/ijet.v1i1.7

Comparative Strength of Concrete Made with Stone Dust Sourced as Fine Aggregate from Abakaliki Ebonyi State and Nkwelle Ezunaka in Anambra State

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Abstract

This study examines the use of stone dust in concrete production as a partial substitute for fine aggregates, using a water-to-cement ratio of 0.6 and a mix ratio of 1:1.5:3. In this study, concrete samples from Nkwelle and Abakaliki will be evaluated for the impact of stone dust on their workability and compressive strength. To assess the concrete's performance at different curing phases, important tests are slump and compressive strength tests. The slump test results showed that the concrete mix had good workability, with a value of 85 mm. We tested compressive strength at 7, 14, 21, and 28 days. At each interval, the Abakaliki samples showed exceptional performance, obtaining compressive strengths of 16.75 N/mm², 20.70 N/mm², 15.40 N/mm², and 16.55 N/mm², respectively. The Nkwelle samples, in contrast, showed strengths of 10.70 N/mm², 12.30 N/mm², 12.20 N/mm², and 13.30 N/mm² throughout the same periods. The increased cement-aggregate bonding and particle size distribution in the Abakaliki samples are responsible for their higher compressive strength. On the other hand, the Nkwelle samples had a more gradual and slower growth of strength, which could be attributed to variations in curing conditions and aggregate qualities. According to the study's findings, especially in places with scarce sand supplies, stone dust can be a practical and sustainable substitute for natural sand in the manufacturing of concrete. However, the final compressive strength is greatly influenced by elements like the quality of the material and the curing conditions. To maximise the potential of stone dust in concrete applications and encourage sustainable building practices, the research suggests further optimisation of the mix design and curing procedures.

Keywords: *Stone dust, fine aggregate replacement, compressive strength, concrete performance, Abakaliki stone dust*

Article History
Received: 31 Dec 2024
Accepted: 13 Jan 2025
Published: 29 Jan 2025

Scan QR code to view•

How to cite this paper: Mmonwuba, N. C., Ugwuoke, V. C., & Stephen, J. C. (2025). Comparative Strength of Concrete Made with Stone Dust Sourced as Fine Aggregate from Abakaliki Ebonyi State and Nkwelle Ezunaka in Anambra State. *IPS Journal of Engineering and Technology*, *1*(1), 21–27. https://doi.org/10.54117/ijet.v1i1.7.

1. Introduction

One of the most widely utilised building materials in the world, concrete is necessary for the construction of transportation networks like roads, bridges, and airports, as well as infrastructure like residential, commercial, and industrial buildings (Adewale & Ogunleye, 2020). Its strength, resilience, and adaptability in design are the reasons for its extensive use (Ugwuanyi & Mmonwuba, (2019). Cement, water, fine and coarse aggregates, and occasionally chemical admixtures make up the composite material known as concrete. The workability, compressive strength, and general performance of concrete are all significantly impacted by fine aggregate, one of these components (Umar & Gambo, 2021).

Natural river sand has long been utilised as the main fine aggregate in the creation of concrete because of its well-graded composition and the angularity of its particles, which improve the concrete's mechanical qualities and workability (Adebayo & Adeola, 2019). But excessive sand mining has resulted in serious environmental damage due to the growing demand for building materials brought on by fast urbanisation and infrastructure growth. Riverbank erosion, aquatic habitat loss, and groundwater resource depletion are all consequences of unchecked river sand extraction (Ugwuanyi *et al* 2018). Furthermore, sand mining has disturbed biodiversity and had a detrimental effect on nearby ecosystems (Chukwu & Nwachukwu, 2018).In order to efficiently replace natural sand as a fine aggregate in concrete without sacrificing quality, researchers and construction engineers are looking for substitute materials due to environmental problems around sand mining (Oluwole & Adeyemi, 2017). Among the other options investigated, stone dust—a byproduct of the crushing of stones—has drawn interest as a potential replacement for natural sand. The mechanical crushing of rocks produces a lot of stone dust, which is frequently considered a waste product (Mahmood, Lawal, & Ogunleye, 2020). According to Adebayo and Chukwu (2020), using stone dust offers a sustainable way to manage the trash produced by quarrying activities in addition to addressing the environmental problems related to sand mining.

In comparison to natural sand, stone dust has a finer particle size distribution, which improves the packing density in the concrete matrix (Mmonwuba, 2018). In addition to improving the binding between the cement paste and the aggregate, this lowers the void ratio and increases durability and compressive strength (Mahmood *et al*., 2020). One important factor that affects concrete's ability to support loads is its compressive strength. Numerous studies have shown that adding stone dust in place of natural sand can enhance concrete's mechanical qualities, especially its early-age strength (Oluwole & Adeyemi, 2017). In contrast to concrete manufactured with natural sand, Adebayo and Adeola (2019) discovered that concrete made with stone dust had greater compressive strength at both the early and later curing stages. This was explained by the finer stone dust particles, which improved concrete mix packing and decreased microcracking as the mixture hydrated.

However, the source and the crushing procedure can affect the quality of stone dust. The performance of concrete can be affected by variables such as the moisture level, the source rock's mineralogical makeup, and the distribution of stone dust particle sizes (Chukwu & Nwachukwu, 2018). For example, excessively fine-particle stone dust can lead to shrinkage and cracking during curing, while high-clay stone dust might make the concrete mix less workable and have a detrimental effect on its compressive strength (Oluwole & Adeyemi, 2017). Therefore, before using stone dust to substitute natural sand in the manufacturing of concrete, it is crucial to carefully assess its physical and chemical characteristics (Uche & Adebisi, 2020).

In Nigeria, areas such as Abakaliki in Ebonyi State and Nkwelle in Anambra State are well-known for their intensive stone quarrying operations. The usage of stone dust generated in these areas as a fine aggregate in regional building projects is growing (Eze *et al*., 2021). Comparing the performance and mechanical characteristics of concrete created with stone dust from various locations hasn't been thoroughly studied, though. Significant changes in the characteristics of the stone dust may arise from regional geological variables, which could have an impact on the concrete's durability, workability, and compressive strength (Mahmood *et al*., 2020). Therefore, more study is required to comprehend how diverse sources of stone dust affect the performance of concrete under varied loading scenarios.
In order to fill the existing knowledge vacuum, this study will assess the compressive strength of concrete that has been created with stone dust from Nkwelle and Abakaliki. The principal aim is to discover the source of stone dust that yields concrete with exceptional mechanical qualities and evaluate its appropriateness for use in building. The performance of concrete made with alternative fine aggregates will be better understood thanks to this research's thorough evaluation of the stone dust's physical characteristics, such as moisture content and particle size distribution, as well as its chemical characteristics, such as mineral composition (Oluwole & Adeyemi, 2017).

Additionally, the economic and environmental advantages of employing stone dust in the manufacture of concrete will be investigated in this study (Agunwamba & Mmonwuba, 2021). When natural sand is substituted with stone dust, the adverse environmental effects of sand mining, including habitat loss, groundwater depletion, and riverbank erosion, can be lessened (Adebayo & Chukwu, 2020). Stone dust is also frequently less expensive than natural sand, which makes it a financially feasible substitute for building projects, especially in areas where sand is expensive or scarce (Chukwu & Nwachukwu, 2018). According to Mahmood *et al*. (2020), this study advances sustainable construction methods by encouraging the use of locally produced materials, guaranteeing that future projects can achieve both environmental and economic goals.

2. Materials and Methods

2.1 Methodology

A thorough assessment of the strength of concrete built using stone dust as fine aggregate from two different locations—Abakaliki in Ebonyi State and Nkwelle Ezunaka in Anambra State—was ensured by the technique for this study. The approach comprises a thorough explanation of the component materials, the procedure for gathering them, initial testing on them, and tests on both fresh and hardened concrete. To get accurate data that supports the study's goals, several processes were conducted methodically.

2.2 Constituent Materials

The constituent materials used for the preparation of concrete samples in this research are cement, stone dust, portable water, and coarse aggregate.

2.2.1 Sample Collection

For the purpose of comparison, stone dust was gathered from Abakaliki and Nkwelle, while cement and coarse aggregate (12 mm chippings) were obtained from Uli. In order to ensure compliance with the necessary criteria, portable water was procured from the Civil Engineering laboratory. In order to preserve quality, every material was thoroughly examined and handled.

2.2.2 Cement

Dangote Cement was selected for this study due to its proven track record of maintaining high quality standards, essential for ensuring the uniformity and functionality of the concrete mix. To preserve its efficiency, the cement was procured fresh from Uli, Anambra State, and protected from moisture exposure. This choice ensures that the concrete mix meets the rigorous requirements of the study, particularly within the local environmental conditions of Anambra State.

2.2.3 Stone Dust

Abakaliki and Nkwelle were the sources of the stone dust employed in this study as fine aggregate. It was chosen because of its capacity to increase the concrete mix's packing density, which lowers voids and increases the concrete's overall strength. Because stone dust has a fine texture and improves particle dispersion, it can be used to produce concrete because it creates a more cohesive mixture. The study examines the effects of sourcing from two distinct areas on the performance of the concrete.

2.2.4 **Coarse Aggregate**

A local distributor in Uli provided the coarse aggregate (chipping) used in this investigation. Particularly, the chipping was chosen to have a nominal size of 12 mm, which is typical and appropriate for the majority of concrete applications. This size guarantees a robust, long-lasting concrete mix by facilitating effective packing and compaction. Before being mixed, the material was examined for contaminants such as dust or organic matter and kept in a controlled atmosphere to preserve its quality. By taking these precautions, the aggregate was guaranteed to satisfy all requirements for the manufacturing of concrete.

2.2.5 **Portable Water**

In order to ensure that the portable water used in this study complied with the quality requirements for use in the manufacturing of concrete, it was obtained straight from the Civil Engineering laboratory. The water was closely inspected and clear of contaminants or impurities that would have impacted the setting and strength development of the concrete, such as oils, acids, or alkalis. Consistency and dependability in the mixing process were made possible by sourcing water from a controlled setting, like a laboratory, which improved the overall quality and functionality of the concrete mixes.

2.3 **Preliminary Tests**

Before the components were added to the concrete mix, preliminary testing was done on them. These tests were crucial for understanding the materials' fundamental characteristics and assessing their suitability for use in the construction of concrete (Ugwuanyi, S. E., & Mmonwuba, N. C. 2019).

2.3.1 Sieve Analysis of Stone Dust

The aim of the sieve analysis was to determine the particle size distribution of the stone dust used as fine aggregate in the concrete mix. This test ensures proper gradation, which influences concrete's workability, strength, and durability.
The apparatus included standard sieves, a sieve shaker, a weighing balance, a tray, and a drying oven. The dried stone dust was sieved through a stack of sieves arranged in descending mesh sizes. The material retained on each sieve was weighed, and the cumulative percentage retained was calculated to assess the gradation.

2.3.2 Slump test

The purpose of the slump test was to gauge the fresh concrete mix's consistency and workability. A slump cone, tamping rod, base plate, and measuring tape were among the tools utilized. The cone was carefully raised vertically after being filled in three layers, each of which was tamped 25 times. The slump value, which indicates the mix's workability, was calculated by measuring the height difference between the slumped concrete and the cone.

2.4 Tests on Hardened Concrete

Testing was done on the hardened concrete to ascertain its mechanical qualities after it had been left to cure for predetermined amounts of time.

2.4.1 Compressive Strength of Concrete Cubes

The test was designed to determine the concrete cubes' compressive strength after 7, 14, and 28 days of curing. Concrete cubes measuring 150 mm by 150 mm by 150 mm, a curing tank, a weighing scale, and a compression testing machine were all part of the equipment. After casting, curing, and surface drying, the cubes were put through a series of tests with progressively increasing loads until they failed. The compressive strength was measured and contrasted with reference values..

3. Results and Discussion

This section displays the findings of experiments performed on concrete samples utilising Nkwelle Ezunaka and Abakaliki stone dust. Sieve analyses for Abakaliki, Nkwelle, slump test, and compressive strength test are among the findings. Following the presentation of each test result in tables and figures, a thorough explanation follows.

Table 1: Sieve Analysis for Abakaliki sample

Sieve Size (mm)	**Weight Retained (kg)**	**Percentage Retained (%)**	**Cumulative Percentage Retained (%)**	**Cumulative Percentage Passing (<%)**
8	1.60	53.33	53.33	46.67
10	0.05	1.67	55.00	45.00
12	0.20	6.67	61.67	38.33
20	0.80	20.00	81.87	18.33
30	0.20	6.67	88.34	11.66
40	0.15	5.00	93.34	6.66
80	0.05	1.67	95.01	4.99
Pan	0.00	0.00	100.00	0.00

Table2: Sieve Analysis for Nkwelle sample

Sieve Size (mm)	Weight Retained (kg)	Percentage Retained (%)	Cumulative Percentage Retained (%)	Cumulative Percentage Passing (%)
8	1.00	33.33	33.33	66.67
10	0.05	16.67	50.00	50.00
12	0.20	6.67	56.67	43.33
20	0.40	13.33	70.00	30.00
30	0.15	5.00	75.00	25.00
40	0.10	3.33	78.33	21.67
80	0.05	1.67	81.68	18.32
Pan	0.00	0.00	100.00	0.00

Table 3: Slump test results for Abakaliki and Nkwelle sample

Material	Location	Water Cement Ratio	Slump Value (mm)	Height of Slump Concrete (mm)
Stone Dust	Abakaliki	0.6	60	240
Stone Dust	Nkwelle Ezunaka	0.7	170	130

Table 4: Compressive Strength Test Results for Stone Dust Samples

S/N	Location	7 days	14 days	21 days	28 days
1	Abakaliki	16.75	20.70	15.40	16.55
2	Nkwelle	10.70	12.30	12.20	13.30

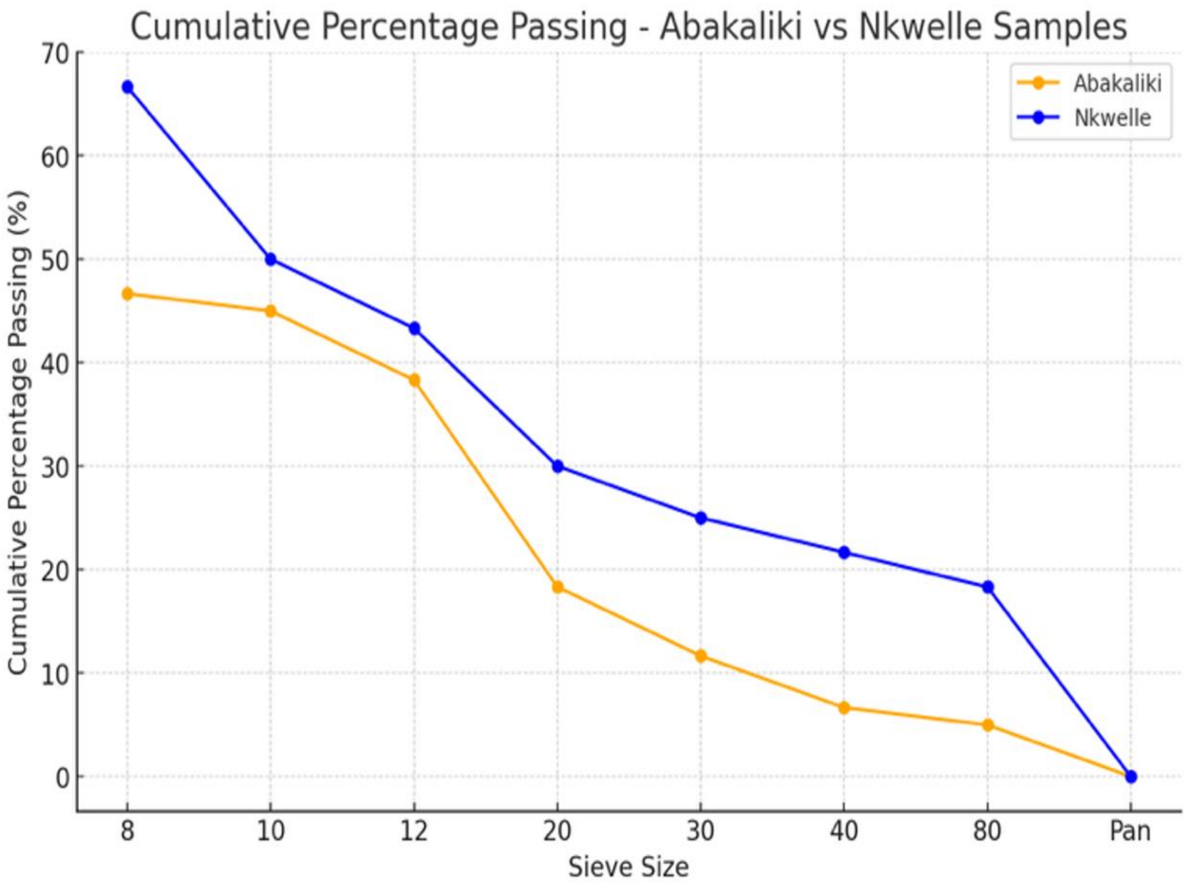

Figure 1: Combined Graph for Abakaliki and Nkwelle Samples

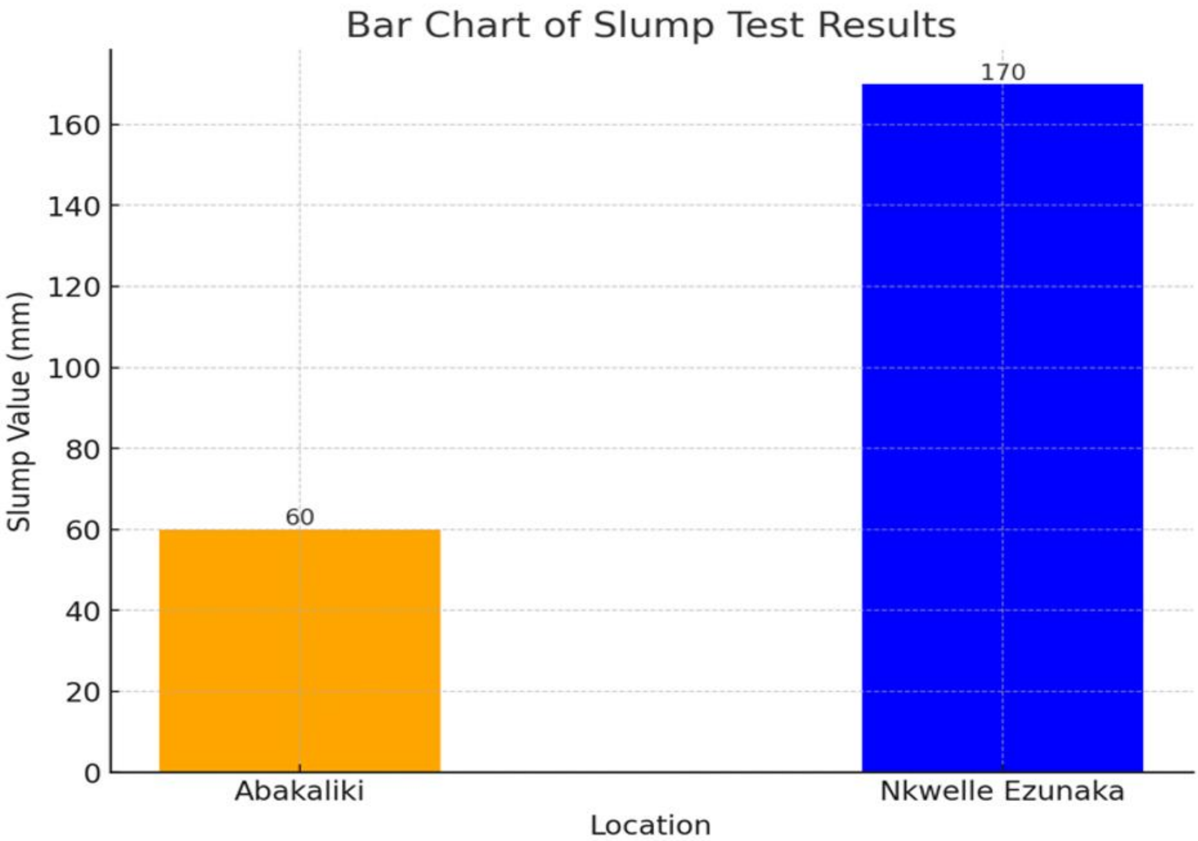

Figure 2: Slump test result for Abakaliki and Nkwelle

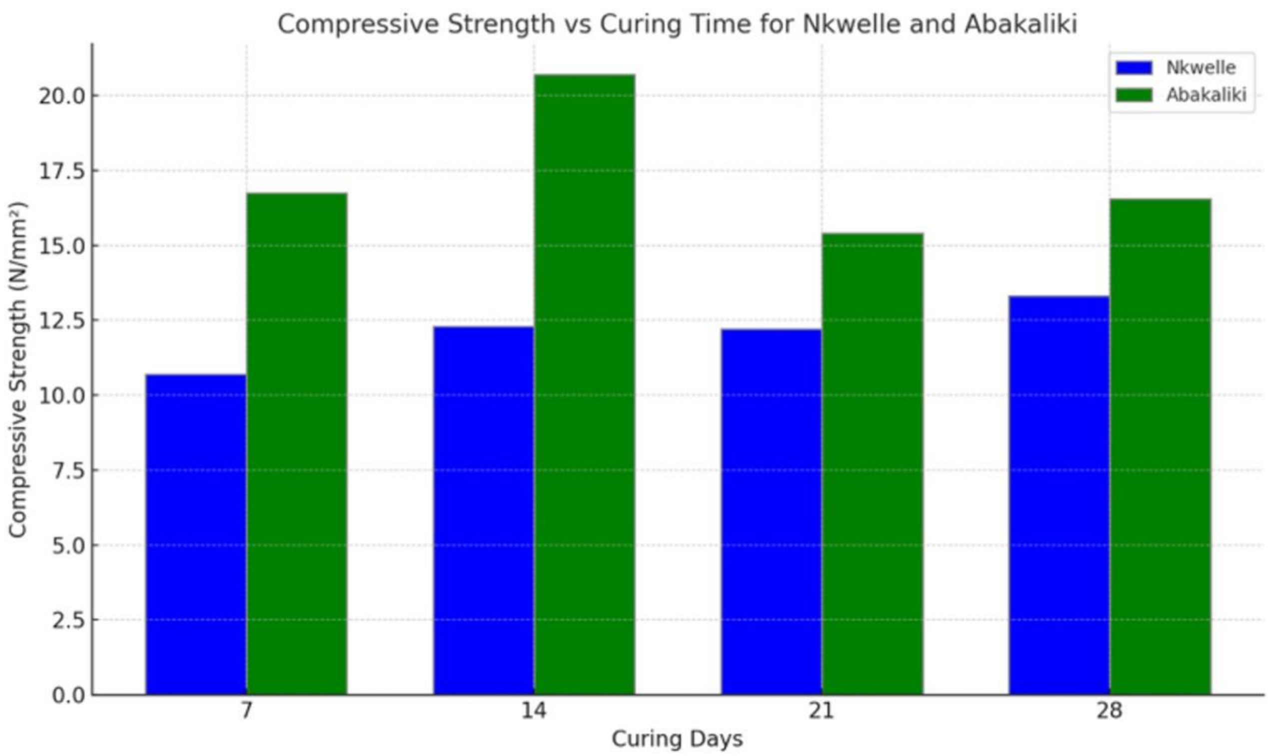

Figure 3: Compressive Strength vs. Curing Time for Stone Dust Samples (Nkwelle and Abakaliki)

3.1 Sieve Analysis

Abakaliki Sample: The coarser gradation improves workability but may reduce compressive strength due to potential voids.

Nkwelle Sample: The finer gradation enhances strength by reducing voids but may decrease workability, requiring more water or additives.

Combined Analysis: The choice of stone dust source affects concrete properties; Abakaliki offers better workability, while Nkwelle provides higher strength.

3.2 Slump test

The results of the slump test showed that the two concrete mixtures' workability varied:

Abakaliki Mix: The mix is easier to lay and compact when it has a slump value of 60 mm, which indicates improved workability. However, if left unchecked, the fluidity—which is indicated by a slump height of 240 mm—may cause bleeding or segregation. Nkwelle Mix: A stiffer mix with less workability but better particle packing is indicated by a slump value of 170 mm. A slump height of 130 mm, which verifies the compact nature, indicates increased density, which raises compressive strength.

3.3 Compressive strength test

The results of the compressive strength test revealed significant variations between the concrete samples from Abakaliki and Nkwelle:

Abakaliki recorded 16.75 N/mm² after 7 days, whereas Nkwelle recorded 10.70 N/mm².This suggests that the Abakaliki mix developed its strength more quickly.• After 14 days, Nkwelle increased to 12.30 N/mm², indicating enhanced particle packing in the Abakaliki mix, while Abakaliki reached 20.70 N/mm².

After 21 days, Nkwelle was steady at 12.20 N/mm², indicating steady curing, while Abakaliki decreased somewhat to 15.40 N/mm².

At 28 days, Nkwelle developed steadily but more slowly, reaching 13.30 N/mm², while Abakaliki maintained superior strength at 16.55 N/mm².

Comparative Analysis: The Abakaliki mix steadily performed better than the Nkwelle mix, most likely as a result of superior curing conditions, particle size dispersion, and material quality. However, because of its finer particles and higher water requirement, the Nkwelle mix showed a slower, more gradual strength growth.

4. Conclusion and Recommendations

4.1 Conclusion

There were notable variations in the mechanical performance of concrete samples from Abakaliki and Nkwelle when stone dust was used as a partial substitute for fine aggregates. Abakaliki samples had higher early-age and overall strength, according to the compressive strength measurements. This was probably because of their improved particle size distribution and compaction properties, which improved bonding within the concrete matrix. This outstanding performance was further enhanced by favourable material qualities and carefully regulated curing conditions.The Nkwelle samples, on the other hand, showed a steady but slower strength growth. Despite being weaker than Abakaliki's after 28 days, the steady and moderate growth indicates dependable long-term performance, which makes it appropriate for uses that don't call for quick strength gains. This study emphasises stone dust's potential as a sustainable raw material for concrete manufacturing. But the diversity that has been seen highlights how crucial it is to optimism mix composition and guarantee strict quality control when acquiring components.

4.2 Recommendations

- Optimize Mix Design: For increased strength and performance, modify the proportions of stone dust and water-cement to fit the characteristics of the local materials.
- Assure Quality Control: To preserve uniformity in concrete strength, test stone dust on a regular basis for particle size, cleanliness, and mineral composition.
- Enhance Curing Methods: To guarantee adequate hydration, use efficient curing strategies, including curing chemicals or ongoing moisture maintenance.
- Additional Research: To evaluate long-term performance, look into additional characteristics like flexural strength, tensile strength, and durability.
- Encourage Sustainability: By using stone dust, you may lessen your dependency on natural sand and encourage environmentally beneficial building methods.
- Locally Adapt Standards: To improve the durability of concrete, match building codes with local material characteristics and environmental circumstances.

Author contribution

All the authors contributed to the development of the work.

Competing interests

The authors declare no competing interests.

References

1. Adewale, A., & Ogunleye, T. (2020). Concrete as a critical material for infrastructure development. Journal of Civil Engineering Research, 12(4), 45-52.
2. Mmonwuba, N. C., Agunwamba, J. C., & Onyekwere, K. O. (2013). Comparative analysis of bioremediation of heavy metals using plants and microorganisms. International Journal of Current Science, 6, E153–E160. 65-73.
3. Ugwuanyi, S. E., Mmonwuba, N. C., & Adibe, T. N. (2018). Challenges of water supply sustainability in an emerging economy. IOSR Journal of Mechanical and Civil Engineering, 15(5), 2278–1684.
4. Eze, J., Nduka, C., & Ibeh, S. (2021). Environmental consequences of river sand mining in Nigeria. Environmental Research and Development Journal, 18(1), 90-105.
5. Mmonwuba, N. C., Anaduaku Mmaduabuchi, C., Azubuike, C., Nweke, N. T., & Chioke, C. (2023). The effect of industrial waste effluent on water quality: A case study of Atamiri River, Owerri, Imo State. Journal of Engineering Research and Reports (JERR), 24, 1–7. https://doi.org/10.9734/jerr/2023/v24i48010
6. Oluwole, K., & Adeyemi, B. (2017). Investigating stone dust as a fine aggregate replacement in concrete. Journal of Sustainable Construction, 10(2), 75-82.
7. Adebayo, T., & Chukwu, O. (2020). Stone dust as a sustainable alternative for fine aggregate in concrete. International Journal of Environmental Engineering, 7(3), 110-118.
8. Uche, I., & Adebisi, M. (2020). Evaluation of stone dust properties for construction applications. Nigerian Journal of Construction Materials, 5(1), 55-63.
9. Ugwuanyi, S. E., Mmonwuba, N. C., & Adibe, T. N. (2018). Partial replacement of cement with burnt rice husk ash for low-

strength concrete production. International Journal of Innovation Engineering, Technology, and Science (IJIETS), 2(2), April.
10. Ugwuanyi, S. E., & Mmonwuba, N. C. (2019). Project failure in Enugu State: Problems, prospects, and perceived solutions. International Journal of Innovation Engineering, Technology, and Science (IJIETS), 2(2), March.
11. Mmonwuba, N. C. (2020). Effect of soak-away on groundwater quality in Onitsha North Local Government Area of Anambra State. International Journal of Innovation Engineering, Technology, and Science (IJIETS), 3(2), October.
12. Agunwamba, J. C., & Mmonwuba, N. C. (2021). Comparative analysis of some existing models for estimating the time of concentration for watersheds in Anambra State. Journal of Engineering Research and Reports (JERR), 20(5), 64–75. https://doi.org/10.9734/jerr/2021/v20i565510
13. Mmonwuba, N. C. (2018). Comparative analysis of paving tiles produced from plastic waste, palm kernel shell, and normal concrete. International Journal of Innovation Engineering, Technology, and Science (IJIETS), 2(1), March.
14. Mmonwuba, N. C., Ezenwaka, P., & Chukwu, E. C. (2023). The design of a sewage treatment plant for Agulu community, Nigeria. Journal of Engineering Research and Reports (JERR), 24, 1–7. https://doi.org/10.9734/jerr/2023/v24i4808
15. Mmonwuba, N. C., Okoye, O. F., Okpala, S., Maduegbunna, P. C., Ezenwafor, K., & Ezeolisa, I. G. (2023). Effect of solid waste (leachates) on the quality of underground water. Journal of Engineering Research and Reports (JERR), 24, 20–31. https://doi.org/10.9734/jerr/2023/v24i38085
16. Mmonwuba, N. C., Anene, W., Onyiriofor, C. M., & Adahor, L. (2023). Hazardous waste management at Our Lady of Lourdes Hospital, Ihiala, Anambra State. American Journal of Innovation in Science and Engineering (AJISE), 2(1). https://journals.e-palli.com/home/index.php/ajise/article/view/1324/632
17. Mmonwuba, N. C. D., Chekwube, O. D., Chibuzor, O. S.-M., & Anthony, A. C. (2023). Bioremediation and phytoremediation of petroleum-contaminated soil. Journal of Engineering Research and Reports (JERR), 15(4), 34–44. https://doi.org/10.9734/jerr/2023/v15i4322
18. Mmonwuba, N. C., Sochima, M. E., Samuel, O. A., & Kizito, M. (2023). Analysis of physical, chemical, and biological characteristics of borehole water in Awka, Awka-South LGA, Anambra State, Nigeria. Journal of Engineering Research and Reports (JERR), 25(12), 116–127. https://doi.org/10.9734/jerr/2023/v25i121046.
19. 19 Mmonwuba, N.C., J. C. Agunwamba, Udeoba Chisom, Nwalioba Francis, and Umechukwu Victor. 2024. "Composting of Cow Dung and Food Waste under Aerobic Conditions for the Improvement of Soil". Asian Journal of Advanced Research and Report 18 (12):483-92. https://doi.org/10.9734/ajarr/2024/v18i12845
20. 20 Mmonwuba, N.C., J.C. Agunwamba, Anaezionwu Ambrose Obumneme, Ileagu Chibuikem Linus, and Nwokedi Alexander Chukwuemelie. 2024. "Comparing the Performance of Physical, Chemical and Biological Treatment in Waste Water Remediation". Asian Journal of Advanced Research and Reports 18 (12):571-85. https://doi.org/10.9734/ajarr/2024/v18i12852
21. 21 Mmonwuba, N. C., Uwanuakwa, A., Nwafor, L., Chidiebere, M. V., & Nwosu, C. (2024). Evaluation of the Effect of Biological Nutrient Removal (BNR) on Wastewater Quality. Journal of Pollution Monitoring, Evaluation Studies and Control, 3(1), 59–66. https://doi.org/10.54117/jpmesc.v3i1.11
22. 22 O. P Ezisi, N. C. Ezugwu. N. C Mmonwuba (2024). The Impact of 2018 Earth Tremors on Groundwater Quality in the Federal Capital Territory Abuja. FUDMA Journal of Science8(6),1-4. https://doi.org/10.33003/fjs-2024-0806-2900
23. 23 Mmonwuba , N. C., Anaduaka Mmaduabuchi, Ohamadike Azubuike, Nweke Nzube Theophilus, and Chioke Chukwuemelie. 2023. "The Effect of Industrial Waste Effluent on Waterquality: A Case Study of Otamiri River, Owerri, Imo State". Journal of Engineering Research and Reports 24 (4):15-25. https://doi.org/10.9734/jerr/2023/v24i4810
24. 24 Mmonwuba Nwanneka, Emmanuel Ifeanyi Ogunjiofor, Ogudebe Chukwuebuka Samuel, Okafor Odinaka kindness, and Dominic Machi Chigozie. 2025. 'The Use of Reinforced Concrete for Durable and Aesthetic Sports and Recreational Sports". Journal of Engineering Research and Report 27(1).188-78. https://doi.org/10.9734/jerr/2025/v27i11376
25. 25 K. C Nwachukwu, N. C. Mmpnwuba, E. I. Ogunjiofor (2025). Compressive Strength Investigation of PSA-MSA-Cement Concrete [PMCC] Using Kings Scheffe's (6,2) Model, 12(1). DOI:10.15680/IJARETY.2025.1201001
26. 26 Dim, B. C. & Mmonwuba, N. C. (2025). Enhancing Concrete Performance in Marine Environment: Insight into Seawater Effects and Cement Optimization. IPS Journal of Physical Sciences, 2(1), 12-19. https://doi.org/10.54117/ijps.v2i1.4

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