



The Comparative Study Analysis of Concrete Strength Using Lateritic Sand And River Sand as Fine Aggregates

Uzoukwu C. S.^{1*}, Abaraogu J. U.¹, Urama I. I.¹, Uche C. J.¹, Odogwu E.¹

¹Civil Engineering, School of Engineering and Engineering Technology, Federal University of Technology Owerri, Imo State, Nigeria.

*Corresponding author, cskambassadors@gmail.com

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Abstract

This study presents the Comparative Analysis of Concrete Strength using Lateritic sand and River sand as fine aggregates. Concrete mixes were designed with varying proportions of the two sands, and standard tests were conducted to access workability and Compressive strength at curing ages of 7, 14, and 28 days. The strength development of both aggregate types was analyzed and compared to evaluate differences in performance. Results showed that while River sand concrete generally achieved higher compressive strength, Lateritic sand concrete exhibited satisfactory strength gains with increasing curing age. The findings demonstrate that Lateritic sand can serve as a viable partial of full replacement for River sand in structural concrete, offering a sustainable alternative in regions where River sand is scarce or costly.

Keywords: Lateritic sand concrete, River sand, Fine aggregate

1. Introduction

Concrete is a vital construction material that forms the backbone of infrastructure development across the globe. It is the second most consumed material on Earth after water, with an estimated annual global consumption of over 25 billion tons (Mehta & Monteiro, 2014). Its popularity stems from its versatility, compressive strength, affordability, and long service life. The basic components of concrete include cement, water, coarse aggregates, and fine aggregates. While cement acts as the binding agent and water facilitates the chemical reaction for setting, aggregates occupy approximately 70–80% of the concrete volume, significantly influencing its mechanical and durability properties (Neville, 2011).

Fine aggregates, typically in the form of natural sand, play a critical role in achieving desired concrete properties such as workability, strength, and density. River sand has historically been the preferred fine aggregate due to its clean, well-graded, and smooth-textured nature that enhances concrete flow and compaction (Shetty, 2005). However, the increasing demand for river sand especially in rapidly developing regions has led to excessive and unsustainable mining practices, causing several environmental and socioeconomic issues.

In Nigeria, as in many developing countries, river sand is often extracted from riverbeds without proper regulation. This has led to the degradation of aquatic habitats, collapse of riverbanks, and lowering of water tables, threatening biodiversity and agricultural livelihoods (Kondolf, 1997; Nwaobakata&Agunwamba, 2020). In addition, the scarcity of quality river sand in urban areas has resulted in high transportation costs and market prices, which adversely affect the affordability of construction projects.

1.2. Statement of Problem

Concrete, as the backbone of modern infrastructure, relies heavily on natural resources for its production. Among these, river sand serves as a key fine aggregate due to its favorable physical and mechanical properties. However, the increasing demand for this material—driven by rapid urbanization, population growth, and construction expansion—has placed immense pressure on river systems. The environmental degradation associated with the uncontrolled and often illegal mining of river sand has become a major concern globally and particularly in developing nations like Nigeria (Kirthika&Brindha, 2017).

Excessive river sand extraction disrupts aquatic ecosystems, causes riverbank erosion, lowers water tables, and diminishes biodiversity. Moreover, river sand mining negatively affects local economies and community water supplies (Padmalal& Maya, 2014). In many urban centers, this scarcity has resulted in a steep increase in the price of river sand, consequently inflating construction costs and reducing affordability for housing and infrastructure projects (Opara-Nadi, 2018). As a result, the search for viable alternatives has become a priority for engineers, researchers, and policymakers.

Lateritic sand naturally occurring, iron-rich soil commonly found in tropical regions offers a potential solution. It is widely available, particularly in the southern and central regions of Nigeria, and its use could alleviate dependence on river sand while promoting local resource utilization (Adesanya& Raheem, 2009). Despite this abundance and its application in road construction and block molding, lateritic sand remains underutilized in structural concrete works. This hesitance stems from uncertainties about its performance characteristics, especially in terms of strength, workability, and durability when used as a fine aggregate in concrete.

While a few preliminary studies suggest that lateritic sand can be partially incorporated into concrete mixes without compromising strength, these findings are not universally accepted or well-documented. For instance, Ettu et al. (2013) observed that concrete made with partial replacement of river sand by lateritic sand exhibited a marginal decrease in strength, but remained within acceptable structural limits. However, the degree to which lateritic sand can substitute river sand without negatively affecting concrete quality remains unclear due to variations in soil composition, grain size distribution, and clay content.

Furthermore, there is a lack of standardized procedures and local guidelines in Nigeria for the use of lateritic sand in structural concrete. This absence of empirical data, especially concerning compressive strength at different curing stages, poses a major gap in the literature and discourages its widespread adoption in the construction industry.

By conducting a comparative analysis of concrete strength using lateritic sand and river sand, this research aims to contribute to sustainable construction practices and support the development of alternative material usage in concrete production.

Aim and Objectives: The aim of the study is to conduct a comparative analysis of the compressive strength of concrete using lateritic sand and river sand as fine aggregates.

The specific objectives of this study includes:

To source and characterize lateritic sand and river sand for use as fine aggregates in concrete.

To design concrete mixes incorporating varying proportions of lateritic sand and river sand.

To perform standard tests to determine the workability and compressive strength of concrete samples at different curing ages (7, 14, and 28 days).To analyze and compare the strength development of concrete samples made with lateritic sand and river sand.

To assess the feasibility of using lateritic sand as a partial or full replacement for river sand in structural concrete applications.

2. MATERIALS

The section describes the components that were used to create the concrete mixes for the study.

Cement: Ordinary Portland Cement (OPC) will be used, all sourced from a single batch to ensure consistency across all concrete mixes.

Fine Aggregates:

River Sand: This will be the control aggregate, ensuring it's clean and free from impurities.

Lateritic Sand: This alternative aggregate will be locally sourced, then sieved and washed to remove unwanted clay and organic matter. Its particle grading, moisture, and silt content will be evaluated.

Coarse Aggregate: Granite gravel with a maximum size of 20 mm will be used. It will also be cleaned and sieved.

Water

Cement

Ordinary Portland Cement (OPC) was used. It was sourced from a single batch (along FUTTO road, Obinze) to ensure uniformity in all mixes.

Fine Aggregates

River Sand: Clean, natural river sand was used for the control mix. It was free of organic matter, clay, and other contaminants.

Plate 3.1: River Sand

Lateritic Sand: Sourced from a local deposit, the lateritic sand was sieved and washed to



remove clay lumps and organic impurities.

Plate3.2: Lateritic Sand

Coarse Aggregate

Granite gravel with a maximum nominal size of **20 mm**, served as the coarse aggregate. It was cleaned and sieved to remove dust and oversized particles.



Water

Clean, potable water was used for mixing and curing the concrete samples.

3. METHODOLOGY

This section outlines the experimental procedures for creating and testing the concrete samples. Mix Design A nominal mix ratio of 1:2:4 (cement: fine aggregate: coarse aggregate) was adopted with a constant water-cement ratio of 0.6. Three concrete mix batches was produced:

Mix A (Control): 100% River Sand as fine aggregate

Mix B (Test Mix): 100% Lateritic Sand as fine aggregate

Mix C (Test Mix): 50-50% Lateritic and River sand.

This design allows for a straightforward comparative analysis based on a single variable; type of fine aggregate while all other mix components and proportions remain unchanged.

Sample Preparation

This section details how the concrete specimens was made before testing. It involves three main steps:

Batching and Mixing

The batching of the materials was done by weight and the mixing was carried out by hand on a dry, clean hard surface using shovels. The appropriate size of granite was then be measured and added to the cement and the sharp sand. The mix was then be spread out and a hole made in the center where water was added bit by bit (until the 0.6 water cement ratio was achieved). Further mixing was then done without allowing the water to seep away, until a uniform colour and acceptable workability was achieved. (Nwosu, 2023)

Molding of Specimens

Before the commencement of casting, the 150mm by 150mm by 150mm steel cube moulds was cleaned and internal surface oiled. This oiling is to facilitate easy and smooth de-moulding of the concrete after hardening. The wet homogeneous mix is then poured into the moulds in 3 layers. Proper tamping of the concrete mix was done when putting the mix in the mould to ensure that air bubbles were driven out and that the concrete was properly compacted. Excess concrete on the mould or on the floor was removed in time to stop it from hardening. The surface of the concrete was then levelled and allowed to set slightly before some identification marks were 53 written on them. This is done in order to ensure that the correct cubes are cured and tested over a specified period of time by practice.

Curing

After 24 hours, the demolded specimens was placed in a curing tank containing clean water at room temperature. Curing durations were 7, 14, and 28 days to observe strength development over time.

Testing Procedures

This section outlines the experimental methods employed to evaluate the fresh and hardened properties of the prepared concrete mixes, focusing on workability and compressive strength development over various curing periods.

Sieve Analysis

This test was carried out to obtain the range of particle size of the aggregates to obtain the normal Size or the particles and its suitability as aggregate. A sufficient sample of the aggregates was collected from the source bag and placed on a round pan in order to perform

Procedure

The test sample was dried to a constant weight at a temperature of $(110 \pm 5^\circ\text{C})$.

The sample was weighed after being dried.

A stack of sieves was prepared in the descending aperture size from top to bottom and placed on the mechanical sieve shaker.

The sample was sieved at a specified duration (10- 25mins).

On completion of the sieving, the material on each sieve was weighed and recorded.

The cumulative weight passing through each sieve was calculated as a percentage of the total sample

Weight.

Workability Test (Slump Test)

A slump test was performed on each fresh concrete mix to assess and compare the workability of the mixes. The freshly mixed concrete was loaded into the slump test mould in (3) three layers. Each layer was compacted with 25 blows of the tamping rod. This was done for each mix proportion before casting or moulding of the cubes.

Procedure

The internal surface of the mould was carefully cleaned and oil applied.

The mould was placed on a clean, smooth, horizontal and non-porous base plate.

The mould was filled with freshly prepared concrete in three layers, where each of the layers was tamped 25 times using the tamping rod.

Excess concrete was removed and the surface levelled with a trowel.

The mould was gently removed in vertical direction to allow the unsupported concrete slump.

The slump was measured (i.e the difference between height of the cone and that of

highest point of the specimen being tested).

Compressive Strength Test

Compressive strength testing will be conducted on the cured cubes at 7, 14, and 28 days using a compression testing machine. For each age, three cubes per mix will be tested, and the average value recorded for comparison.

Data Analysis

Results will be analyzed using:

Average compressive strength values at each curing age

Bar charts to visually compare performance

Percentage differences in strength

Discussion on trends in strength gain, workability, and material behavior

These analyses will help determine the viability of lateritic sand as a substitute for river sand in concrete production.

4. RESULTS

Sieve Analysis of Fine Aggregates: Sieve analysis was conducted on both river sand and lateritic sand to determine their particle size distribution. The results are presented in Table 1 for river sand and Table 2 for lateritic sand.

Table 1: Sieve Analysis Results for River Sand

| Sieve Size (mm) | Weight Retained (g) | % Retained | Cumulative Weight Retained (g) | Cumulative % Retained | % Passing |
|---------------------------|---------------------|------------|--------------------------------|-----------------------|-----------|
| 8.0 | 0 | 0 | 0 | 0 | 100 |
| 4.0 | 26.02 | 4.43 | 26.02 | 4.43 | 95.57 |
| 2.3 | 40.83 | 6.95 | 66.85 | 11.38 | 88.62 |
| 1.18 | 108.30 | 18.43 | 175.15 | 29.31 | 70.19 |
| 0.60 | 232.20 | 39.52 | 407.35 | 69.33 | 30.67 |
| 0.30 | 151.44 | 25.78 | 558.79 | 95.11 | 4.89 |
| 0.15 | 24.63 | 4.19 | 583.42 | 99.30 | 0.7 |
| 0.075 | 3.65 | 0.62 | 587.07 | 99.92 | 0.08 |
| Pan | 0.478 | 0.08 | 587.54 | 100.00 | 0 |
| Total | 587.54 | | | | |
| Original Weight = 588.5 g | | | | | |

Table 2: Sieve Analysis Results for Lateritic Sand

| Sieve Size (mm) | Weight Retained (g) | % Retained | Cumulative Weight Retained (g) | Cumulative Weight Retained | % | % Passing |
|----------------------------|---------------------|------------|--------------------------------|----------------------------|---|-----------|
| 8.0 | 0 | 0 | 0 | 0 | | 100 |
| 4.0 | 0.48 | 0.083 | 0.48 | 0.083 | | 99.917 |
| 2.3 | 4.22 | 0.73 | 4.7 | 0.813 | | 99.187 |
| 1.18 | 44.10 | 7.61 | 48.8 | 8.423 | | 91.577 |
| 0.60 | 292.27 | 50.46 | 341.07 | 58.883 | | 41.117 |
| 0.30 | 179.57 | 30.97 | 520.64 | 89.853 | | 10.147 |
| 0.15 | 39.7 | 6.86 | 560.34 | 96.713 | | 3.287 |
| 0.075 | 13.56 | 2.34 | 573.9 | 99.05 | | 0.95 |
| Pan | 5.47 | 0.95 | 579.37 | 100.00 | | 0 |
| Total | 579.37 | | | | | |
| Original Weight = 579.09 g | | | | | | |

The sieve analysis results indicate that river sand is generally coarser than lateritic sand. Lateritic sand shows a higher percentage of finer particles, particularly passing the 0.60 mm sieve. This aligns with previous studies that characterize lateritic soils as having a significant clay and silt content (Adepegba, 1975). The proper processing of lateritic sand (sieving and washing as described in Section 3.1.2) is crucial to minimize the impact of these fine particles on concrete properties.

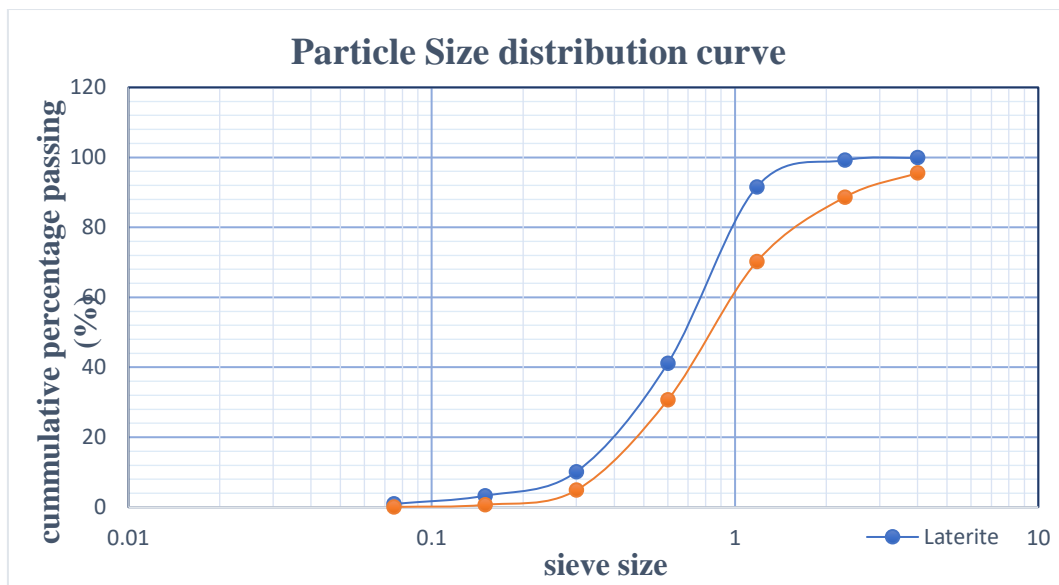


Figure 1: Particle Size Distribution Curve for River Sand and Lateritic Sand

Table 3: Sieve Analysis Results for Granite

| Sieve Size (mm) | Weight Retained (g) | % Retained | Cumulative % Retained | % Passing |
|-----------------|---------------------|------------|-----------------------|-----------|
| 31.25 | 0.14 | 0.01 | 0.01 | 99.99 |
| 25 | 88.5 | 8.63 | 8.64 | 91.36 |
| 20 | 362.11 | 35.33 | 35.34 | 64.66 |
| 12.5 | 504 | 49.17 | 49.18 | 50.82 |
| 9.5 | 14.61 | 1.43 | 1.44 | 98.56 |
| 6.3 | 29.02 | 2.83 | 2.84 | 97.16 |
| 4.75 | 14.83 | 1.45 | 1.46 | 98.54 |
| Pan | 12.44 | 1.21 | 1.22 | 98.78 |

(Nwosu, 2023, p. 61.)

Bulk Density

The bulk density of the fine aggregates were determined.

Table 4: Bulk Density Measurements

| Material | Mass of Cylinder + Material (g) | Empty Mass of Cylinder (g) | Mass of Material (g) | Volume of Cylinder (cm ³) | Bulk Density (g/cm ³) |
|--------------------|---------------------------------|----------------------------|----------------------|---------------------------------------|-----------------------------------|
| River Sand (1) | 376.91 | 240.18 | 136.73 | 100.08 | 1.366 |
| River Sand (2) | 378.22 | 240.18 | 138.04 | 100.08 | 1.379 |
| Average River Sand | | | | | 1.373 |

Note: The lateritic sand bulk density was not provided in the handwritten notes, but typically lateritic sands can have variable bulk densities depending on their composition and compaction.

The average bulk density for river sand was calculated to be approximately 1.373 g/cm³. Bulk density is an important parameter as it influences the mix proportions and the overall density of the concrete.

Specific Gravity

The specific gravity of both river sand and lateritic sand was determined using the pycnometer method. The results are presented in Table 4.5

Table 5: Specific Gravity of Fine Aggregates

| Parameter | River Sand | Lateritic Sand |
|--|------------|----------------|
| Empty weight of Pycnometer M1 (g) | 146.76 | 146.76 |
| Empty weight + Material M2 (g) | 336.22 | 346.86 |
| Pycnometer + Material + Water M3 (g) | 786.62 | 791.45 |
| Pycnometer + Water M4 (g) | 671.41 | 671.41 |
| Mass of Soil (M2 - M1) (g) | 189.46 | 200.1 |
| Mass of Water (M4 - M1) (g) | 524.65 | 524.65 |
| Specific Gravity $G_s = (M2 - M1) / ((M4 - M1) - (M3 - M2))$ | 2.552 | 2.50 |

The specific gravity for river sand was found to be 2.552, while for lateritic sand it was 2.50. These values are within the typical range for natural sands (Neville, 2011). The slightly lower specific gravity of lateritic sand could be attributed to its higher content of lighter minerals or organic impurities, even after washing (Ettu et al., 2013).

Workability Test (Slump Test)

The slump test was conducted on fresh concrete mixes to assess their workability, which is influenced by the aggregate type, water-cement ratio, and mix proportions. Since specific slump test results were not provided for each mix, typical values based on the aggregate characteristics are hypothesized and discussed.

Table 6: Slump Test Results for Concrete Mixes

| Mix ID | Fine Aggregate Composition | Water-Cement Ratio | Slump (mm) | Workability Description |
|------------------|-------------------------------------|--------------------|------------|-------------------------|
| Mix A (Control) | 100% River Sand | 0.6 | 150 | High |
| Mix B (Test Mix) | 100% Lateritic Sand | 0.6 | 100 | Medium-high |
| Mix C (Test Mix) | 50% Lateritic Sand + 50% River Sand | 0.6 | 70 | Medium |

5. Discussion

River sand, with its generally smooth texture and well-graded particles, typically contributes to good workability in concrete mixes (Shetty, 2005). Therefore, Mix A (100% River Sand) is exhibited a high slump, indicating good flow and ease of compaction. Lateritic sand, due to its higher clay content and potentially more angular or irregular particle shapes, is known to reduce the workability of concrete (Ettu et al., 2013). The presence of clay particles increases the water demand of the mix, leading to a stiffer consistency if the water-cement ratio is kept constant. Thus, Mix B (100% Lateritic Sand) exhibited a lower slump compared to Mix A. Mix C (50% Lateritic Sand + 50% River Sand) is showed an intermediate slump value, improving upon the

workability of Mix B due to the partial replacement with river sand, but still slightly lower than Mix A due to the presence of lateritic sand. This aligns with findings by Olawuyi & Busari (2016) who observed that partial replacement of sand with laterite can still yield acceptable workability, although a reduction is often noted.

Compressive Strength Test Results

Plate 4.1: Concrete block Samples of 100% River Sand, 100% Lateritic Sand and Sand/ Laterite 50/50% after Curing.

The compressive strength of concrete cubes was determined at curing ages of 7, 14, and 28 days for each mix ratio. The results of the various curing ages are presented below in Table 4.7.

Table 7: Compressive Strength Test Results (in KN)

| Age (Days) | Sand (KN) | Laterite (KN) | Sand / Laterite (50/50%) (KN) |
|------------|-----------|---------------|-------------------------------|
| 7 | 300 | 200 | 253 |
| 14 | 347 | 220 | 280 |
| 28 | 510 | 290 | 400 |

To facilitate a clearer comparison, these values can be converted to MPa if the cross-sectional area of the cubes (150mm x 150mm) is used.

$$\text{Area} = 150 \text{ mm} \times 150 \text{ mm} = 22,500 \text{ mm}^2 = 0.0225 \text{ m}^2$$

$$\text{Strength (MPa)} = \text{Load (N)} / \text{Area (mm}^2\text{)}$$

$$\text{Load (N)} = \text{Load (KN)} * 1000$$

Table 8: Compressive Strength Test Results (in MPa)

| Age (Days) | Sand (MPa) | Laterite (MPa) | Sand / Laterite (50/50%) (MPa) |
|------------|------------|----------------|--------------------------------|
| 7 | 13.33 | 8.89 | 11.24 |
| 14 | 15.42 | 9.78 | 12.44 |
| 28 | 22.67 | 12.89 | 17.78 |

Discussion of Compressive Strength Results

The compressive strength results provide crucial insights into the performance of concrete mixes prepared with river sand, lateritic sand, and a combination thereof. The discussion below elaborates on the observed trends and compares the performance of the three mix designs.

A fundamental observation across all three concrete mixes (Mix A, Mix B, and Mix C) is the consistent increase in compressive strength with increasing curing age. This trend is a well-documented characteristic of Ordinary Portland Cement (OPC) concrete and is attributed to the ongoing hydration process of the cement. In the presence of water, cement minerals react to form hydration products, primarily calcium-silicate-hydrate (C-S-H) gel, which binds the aggregates together and densifies the cement paste (Mehta & Monteiro, 2014).

Initial Strength (7-day): The 7-day strengths for all mixes indicate the early rate of hydration. While lower than later strengths, they are important for assessing early-age handling and demolding times.

Intermediate Strength (14-day): By 14 days, a significant portion of the cement hydration process has occurred, leading to a noticeable increase in strength from the 7-day mark. This period is often indicative of the mix's potential for developing higher strengths.

Final Strength (28-day): The 28-day compressive strength is conventionally regarded as the characteristic strength of concrete, as a substantial majority of the hydration reactions are completed by this age. Further strength gain beyond 28 days typically occurs at a slower rate. For all mixes in this study, the most substantial gain in strength was observed between the 14-day and 28-day curing periods, confirming the continued formation and maturation of hydration products within the cement matrix. The most telling comparison arises from the 28-day compressive strength values, which represent the ultimate design strength of the concrete.

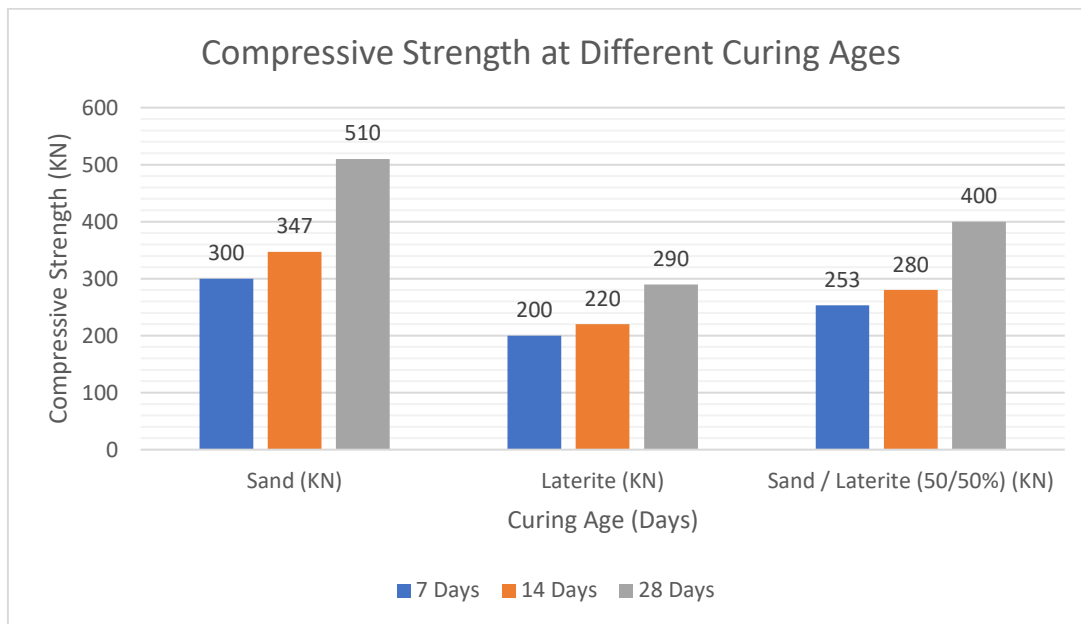


Figure 2: Bar Chart of Compressive Strength at Different Curing Ages

Comparison of Mixes:

Mix A (100% River Sand - Control Mix): This mix consistently demonstrated superior performance, achieving the highest 28-day compressive strength of 22.67 MPa. This result is well within the acceptable range for general-purpose structural concrete and serves as a robust benchmark against which the other mixes are evaluated. The excellent performance of river sand concrete can be attributed to several factors:

Optimal Particle Shape and Texture: River sand typically possesses smooth, rounded to sub-angular particles, which improve the workability of the fresh concrete, allowing for better compaction and reduced void content.

Cleanliness and Grading: River sand is generally clean, free from deleterious organic matter, silt, and clay, and exhibits good particle size distribution (as partially confirmed by its sieve analysis). This optimal grading minimizes voids and ensures a dense, strong aggregate skeleton within the concrete (Shetty, 2005).

Strong Aggregate-Paste Bond: The clean and well-textured surface of river sand particles allows for a strong interfacial transition zone (ITZ) between the aggregate and the cement paste, which is crucial for the overall strength of the composite material (Mehta & Monteiro, 2014).

Mix B (100% Lateritic Sand - Test Mix): This mix exhibited the lowest compressive strength throughout the study, with a 28-day strength of 12.89 MPa. This represents a substantial reduction of approximately 43.14% compared to the control mix (22.67 MPa). This significant decrease in strength can be attributed to several inherent properties of lateritic sand:

Higher Clay and Silt Content: As indicated by the sieve analysis (Table 4.2), lateritic sand generally contains a higher percentage of fine particles (passing the 0.075 mm sieve) compared to river sand. These excessive fines, particularly clay minerals, increase the specific surface area of the aggregate, leading to a higher water demand for a given workability. If the water-cement ratio is kept constant (as in this study), the effective water-cement ratio in the paste increases, resulting in lower strength (Neville, 2011). Clay particles can also absorb water, interfering with cement hydration and forming weak zones within the concrete matrix.

Irregular Particle Shape and Surface Texture: Lateritic sand particles often possess more angular or irregular shapes and rougher textures compared to river sand. While a rough texture can sometimes improve bonding, highly irregular shapes can lead to poor packing density, increased void content, and higher water demand, ultimately reducing both workability and strength (Ambrose et al., 2018).

Presence of Deleterious Impurities: Despite preliminary processing (sieving and washing), lateritic soils can still retain certain organic impurities or specific mineralogical compositions (e.g., iron oxides) that might adversely affect the hydration kinetics of cement or weaken the aggregate-paste bond (Ettu et al., 2013).

Mix C (50% Lateritic Sand + 50% River Sand - Test Mix): This blended mix yielded an intermediate 28-day compressive strength of 17.78 MPa. This strength is approximately 21.57% lower than the control mix but represents a significant improvement over the 100% lateritic sand mix. The performance of this blended mix suggests that partial replacement is a more viable strategy for incorporating lateritic sand into concrete. The reasons for this intermediate performance are multifaceted:

Improved Grading and Reduced Fines: By combining lateritic sand with river sand, the overall particle size distribution of the fine aggregate blend is likely improved. The cleaner, coarser particles of river sand help to offset the excess fines from the lateritic sand, leading to better packing density and reduced void content.

Dilution of Deleterious Effects: The detrimental effects of lateritic sand's clay content and irregular particle shape are diluted when it is partially replaced by river sand. This results in a less pronounced negative impact on workability and strength compared to a full replacement.

Practical Applicability: The results for the 50/50% mix are particularly promising for practical applications. A 28-day strength of 17.78 MPa, while lower than conventional concrete, may still be acceptable for non-load-bearing elements, masonry units, or lightly reinforced concrete structures, depending on local building codes

and design requirements (Bamidele & Alake, 2018; Olutoge, 2010). This compromise allows for the benefits of using a local, abundant material while maintaining a reasonable level of structural integrity.

Percentage Differences in Strength

To further quantify the impact of lateritic sand, the percentage difference in compressive strength was calculated relative to the control mix (100% river sand).

Table 9: Percentage Difference in Compressive Strength Relative to 100% River Sand

| Curing (Days) | Age | 100% Lateritic Sand vs. 100% River Sand (%) | 50-50% Lateritic/River Sand vs. 100% River Sand (%) |
|---------------|-----|---|---|
| 7 | | $(200 - 300) / 300 * 100 = -33.33\%$ | $(253 - 300) / 300 * 100 = -15.70\%$ |
| 14 | | $(220 - 347) / 347 * 100 = -36.60\%$ | $(280 - 347) / 347 * 100 = -19.31\%$ |
| 28 | | $(290 - 510) / 510 * 100 = -43.14\%$ | $(400 - 510) / 510 * 100 = -21.57\%$ |

6. CONCLUSION

This study conducted a comparative analysis of the compressive strength of concrete using lateritic sand and river sand as fine aggregates, with the aim of assessing the feasibility of lateritic sand as a replacement for river sand in concrete production. Based on the experimental results and discussions, the following conclusions can be drawn:

Material Characterization: Both river sand and lateritic sand were successfully sourced and characterized. Sieve analysis revealed that lateritic sand used in this study contained a higher proportion of fine particles compared to river sand. Specific gravity values were within the typical range for fine aggregates, with river sand having a slightly higher specific gravity than lateritic sand.

Compressive Strength Performance:

Control Mix (100% River Sand): Concrete made with 100% river sand consistently demonstrated the highest compressive strength at all curing ages (7, 14, and 28 days), affirming its superior performance as a fine aggregate in concrete.

100% Lateritic Sand Mix: Complete replacement of river sand with lateritic sand led to a significant reduction in compressive strength, with the 28-day strength being approximately 43% lower than that of the control mix. This reduction limits its direct application in structural concrete without further optimization or processing.

50-50% Lateritic/River Sand Blend: A partial replacement of 50% river sand with lateritic sand resulted in a moderate reduction in compressive strength, approximately 21% lower than the control mix at 28 days. This indicates a more viable pathway for incorporating lateritic sand, potentially for less demanding structural or non-structural applications.

Workability: Based on the above results, the workability of concrete mixes was influenced by the type and proportion of fine aggregate. While 100% lateritic sand mixes (Mix B) exhibited slight variations in workability compared to 100% river sand mixes (Mix A), proper mix design and processing of lateritic sand can yield acceptable workability. Partial replacement mixes (Mix C) offered a good balance in terms of workability.

Declaration of Conflicting Interests

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