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Effect of Naka Laterite Rock Finess As a Partial Replacement for Fine Aggregate On The Properties Of Mortar

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ABSTRACT: *The increasing demand for sustainable and locally available construction materials has encouraged the utilisation of lateritic materials as alternatives to conventional fine aggregates in cement-based construction. This study investigated the effects of Naka Laterite Rock Finess (NLRF) as a replacement for river sand on selected physical and mechanical properties of cement mortar. River sand and NLRF were characterised using particle-size distribution and specific gravity tests. Mortar specimens were produced at 1:5 and 1:6 cement-to-fine-aggregate ratios, with NLRF replacing river sand at 0%, 25%, 50%, 75% and 100% by weight, using a water-cement ratio of 0.55. Sixty mortar cubes were cast and cured for 28 days before testing for water absorption, density and compressive strength. The sieve analysis gave coefficients of uniformity of 2.09 and 3.40 and coefficients of curvature of 1.00 and 1.20 for river sand and NLRF, respectively, while their specific gravities were 2.53 and 2.37. Water absorption generally increased with NLRF incorporation from 7–12% for the 1:5 mix and 9–12% for the 1:6 mix. Density varied with NLRF content and mix ratio. Compressive strength ranged from 12.03 to 15.30 N/mm², with the highest recorded at 25% NLRF in 1:5 mix. ANOVA showed significant effects of mix ratio and NLRF percentage on compressive strength ($p < 0.001$), while their interaction was not significant ($p = 0.115$). The study demonstrates the potential of NLRF as a partial replacement for fine aggregate in cement mortar, with 25% replacement identified as a suitable level and therefore recommended for mortar production.*

Keywords: *Naka Laterite Rock Finess, mortar, river sand, water absorption, density, compressive strength*

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I. INTRODUCTION

Mortar is an important cement-based construction material consisting principally of cement, fine aggregate and water, with or without additives (Tangadagi & Ravichandran, 2025; Yaragal et al., 2019). It is widely used for masonry, plastering, rendering, jointing and other construction applications (Yue & Wang, 2024). The performance of mortar is influenced by the characteristics and proportions of its constituent materials, including cement type, water-to-cement ratio, sand-to-cement ratio, aggregate grading, particle shape, curing conditions and age (Kailani et al. 2026). Eskandari-Naddaf and Kazemi (2017) demonstrated that cement strength class and mixture proportions significantly influence the compressive strength of cement mortar. Similarly, Mahdinia et al. (2019) reported that cement strength class, water-to-cement ratio and sand-to-cement ratio are important factors affecting mortar compressive strength.

Fine aggregate is a major component of mortar and provides the granular skeleton within the cementitious matrix (Pruthviraj & Prashanth, 2026). Its properties influence workability, water demand, density and strength (Mehdipour & Khayat, 2017). Natural river sand has traditionally been used as fine aggregate because of its favourable physical characteristics and availability (Rifa et al., 2023). However, increasing construction activities have intensified demand for natural sand, while excessive extraction has raised environmental concerns. Torres et al. (2022) reported that increasing global demand for sand has generated significant environmental and resource-sustainability challenges. The United Nations Environment Programme (UNEP, 2023) similarly identified unsustainable sand extraction as an environmental concern and emphasized the need for responsible management and alternative sources.

The scarcity and increasing cost of conventional fine aggregate have encouraged research into locally available alternative materials. This is particularly relevant in Nigeria, where transportation of construction materials from distant sources can increase construction costs. Ettu et al. (2013) investigated the suitability of laterite as a sole fine aggregate in structural concrete and demonstrated the

potential of lateritic material as an alternative aggregate. Such findings support the investigation of locally available lateritic materials for reducing dependence on conventional sand.

Lateritic materials are products of intense tropical weathering and are commonly characterised by reddish-brown or dark colours (Bertille Ilalie et al., 2024). Its composition and engineering properties vary according to geological origin, degree of weathering, particle-size distribution and mineralogical characteristics. Consequently, lateritic materials from different locations may exhibit different specific gravity, water absorption, grading and strength characteristics. Site-specific characterization is therefore necessary before laterite can be appropriately used as a construction material. The lateritic rock available in Naka is generally fine-grained, with a brownish exterior caused by oxidation and a grey interior.

Several studies have established the potential of laterite as an alternative to conventional fine aggregate. Zebilila et al. (2026) investigated lime-stabilised laterite as a sustainable alternative to river sand, while Garba et al. (2024) and Zaheer et al. (2022) examined laterite as partial fine aggregate replacement in concrete. Yaragal et al. (2019) demonstrated the importance of processing and grading of lateritic aggregates in cement mortars and concrete. Similarly, Renuka et al. (2018), Biju et al. (2018), and Ettu et al. (2013) reported the potential of laterite in cement-based construction. These studies indicate that laterite can replace conventional fine aggregate, although its performance depends on its source, grading, processing and replacement level. The performance of laterized cement-based materials may also vary under environmental exposure. Ige (2013) investigated lateritic concrete under different environmental conditions, including temperature, chemical exposure and alternate wetting and drying, and reported that its performance varied with replacement level and exposure condition. This demonstrates the importance of experimentally evaluating lateritic materials before their wider application. However, limited information exists on the use of Naka Laterite Rock Finess in mortar, creating the need for location-specific investigation of its effects on mortar properties.

Naka District is located in Gwer West Local Government Area of Benue State, Nigeria, approximately between latitude 7.63°N and longitude 8.22°E (Nigeria Geographic Names Database, 2017; Kwaghsaa, 2025). Naka serves as the headquarters of Gwer West Local Government Area, which covers approximately 1,094 km² (Kwaghsaa, 2025). It has locally occurring lateritic rock materials that may provide a potential source of fine aggregate. The use of Naka Laterite Rock Finess could reduce dependence on conventional river sand and potentially reduce transportation requirements where suitable deposits are locally available. However, material availability alone does not establish suitability. The particle-size distribution, specific gravity, bulk density, water absorption and other relevant properties of Naka Laterite Rock Finess need to be determined. In addition, their influence on mortar workability, density, water absorption and compressive strength requires experimental assessment. Although previous studies have demonstrated the potential of lateritic materials as partial or complete replacements for natural sand, the properties of laterite are location-specific. Results obtained from laterite sourced elsewhere cannot automatically be applied to Naka Laterite Rock Finess. Limited site-specific information is available on the use of Naka Laterite Rock Finess in cement mortar, creating uncertainty regarding appropriate replacement levels and their effects on mortar performance. Therefore, this study investigates the effect of Naka Laterite Rock Finess as a partial replacement for fine aggregate on the properties of mortar.

II. MATERIALS AND METHODS

2.1 Materials

The materials used for the study comprised Portland limestone cement, river sand, Naka Laterite Rock Finess and potable water. The materials were selected based on their availability and suitability for mortar production.

Cement: Dangote Portland Limestone Cement (PLC), strength class 42.5N, was used as the principal binding material in the production of the mortar specimens. The cement was obtained from a building-material dealer in North Bank Makurdi, Benue State, Nigeria.

Sand: Natural river sand obtained from the River Benue in Makurdi, Benue State, was used as the conventional fine aggregate. The sand was collected, air-dried and sieved to remove unwanted materials and particles outside the required grading range.

Naka Laterite Rock Finess: Naka Laterite Rock Finess (NLRF) were obtained from a lateritic deposit at Naka in Gwer West Local Government Area of Benue State, Nigeria.

Water: Potable water obtained from Joseph Sarwuan Tarka University, Makurdi, was used for both mixing and curing of the mortar specimens.

2.2. Preparation of Naka Laterite Rock Finess

The Naka lateritic material collected from the Naka deposit was transported to the Civil Engineering Laboratory, Joseph Sarwuan Tarka University, Makurdi, where it was air-dried and prepared for use. Large lumps of the material were manually broken and crushed to reduce their particle size and facilitate uniform processing. The crushed material was passed through appropriate sieves to obtain the fraction suitable for use as fine aggregate. Material retained above the upper sieve and particles passing the 75 µm sieve were removed, while the fraction passing the upper fine-aggregate sieve and retained on the 75 µm sieve was collected for use as NLRF. The processed material was subsequently stored in clean containers until required for mixing.

2.3 Experimental Design and Mix Proportioning

Two cement-to-fine-aggregate mix ratios were investigated, namely 1:5 and 1:6. For each mix ratio, river sand was replaced with NLRF at five replacement levels of 0, 25, 50, 75 and 100% by weight. The 0% replacement level served as the control mixture and contained only conventional river sand as the fine aggregate. At 25% NLRF, one-quarter of the river sand was replaced with NLRF; at 50%, half of the river sand was replaced; at 75%, three-quarters was replaced; and at 100%, the river sand was completely replaced by NLRF as shown in Table 1. A

water-cement ratio of 0.55 was maintained for the mortar mixtures.

Table 1: Mix Proportion of Naka Laterite Rock Finess (NLRF)

Mix Ratio	NLRF Replacement (%
1:5	0
1:5	25
1:5	50
1:5	75
1:5	100
1:6	0
1:6	25
1:6	50
1:6	75
1:6	100

2.4 Preparation of Mortar Specimens

The required quantities of cement, sand and NLRF were measured according to the predetermined mix proportions. The dry materials were thoroughly mixed to obtain a uniform distribution of the cement and fine aggregate constituents. The required quantity of water was then added gradually while mixing continued until a homogeneous mortar of uniform consistency was obtained. The fresh mortar was placed into clean, properly oiled 150 mm × 150 mm × 150 mm cube moulds. The moulds were filled in three approximately equal layers. Each layer was adequately compacted to remove entrapped air and ensure proper filling of the moulds. The surface of each specimen was levelled and finished after the mould had been completely filled. Six cubes were produced for each treatment combination, making the total of 60 cubes produced. After casting, the moulded mortar specimens were kept undisturbed under laboratory conditions for approximately 24 hours to allow sufficient initial setting. After 24 hours, the specimens were carefully demoulded and labelled according to their respective mix ratio and NLRF replacement level. The demoulded cubes were subsequently immersed completely in clean water in curing tanks and cured for 28 days.

2.5 Experimental Method

(A) Sieve Analysis

Sieve analysis was conducted on the fine and coarse aggregates to determine their particle-size distribution and grading characteristics. A series of standard sieves was used to separate the aggregate particles according to size. The procedure was conducted in accordance with BS 812-103:(1990).

(B) Specific Gravity Test

The specific gravity of the fine aggregates (River sand and NLRF) was determined to establish the ratio of the density of the aggregate particles to the density of an equivalent volume of water. The specific gravity test was carried out in accordance with the method described in BS EN 1097-6:(2022). The specific gravity was calculated using equation (1).

$$Gs = \frac{M_2 - M_1}{(M_4 - M_1) - (M_3 - M_2)} \quad (1)$$

Where, Gs = specific gravity, M_1 = weight of empty flask, (g), M_2 = weight of empty flask + weight of the sample, (g), M_3= weight of empty flask + weight of the sample + water, (g), M_4 = weight of empty flask + water, (g)

(C) Water Absorption Test

The water absorption test was conducted to determine the amount of water absorbed by the hardened mortar cube specimens. The test was carried out in accordance with BS 1881-122:(1983). Water absorption was calculated using equation (2):

$$W_a = \frac{W_2 - W_1}{W_1} \times 100 \quad (2)$$

W_a = Water absorption (%), W_1 = weight of oven dried cube (kg), W_2 = weight of wet cube (kg)

(D) Density Test: The mortar cube density was determined by dividing the mass of each cube by its volume as specified by BS EN 12350-6:(2019). The volume of each specimen was calculated using equation (3).

$$\text{Density } (\rho \text{ in kg}/m^3) = \frac{\text{mass of cube (kg)}}{\text{volume of cube } (m^3)} \quad (3)$$

(h) Compressive Strength Test

The compressive strength test was conducted to determine the load-bearing capacity of the hardened mortar cube. The cured 150 mm × 150 mm × 150 mm cube specimens were tested using a compression testing machine at 28 curing age. The test was conducted in accordance with BS EN 12390-3:(2019). The compressive strength was calculated using equation (4).

$$\text{Compressive Strength } (\sigma \text{ in N/mm}^2) = \frac{\text{crushing load of cube (N)}}{\text{Area of cubes (mm}^2)} \quad (4)$$

2.6 Statistical Analysis

The experimental data obtained from the laboratory tests were subjected to descriptive and inferential statistical analyses to determine whether the observed differences in mortar properties were statistically significant. Descriptive statistics, including mean and standard deviation, were used to summarize the measured properties of the mortar. A two-way analysis of variance (ANOVA) was employed to assess the effects of mix ratio (1:5 and 1:6) and Naka Laterite Rock Fines (NLRF) replacement level (0%, 25%, 50%, 75% and 100%) on compressive strength and density. The factorial arrangement comprised ten treatment combinations, with three independent replicate specimens per combination, giving a total of 30 observations for the statistical analysis. The analysis also examined the interaction effect between mix ratio and NLRF replacement level. The two-way ANOVA model included mix ratio, NLRF replacement level and their interaction as fixed effects. Statistical significance was evaluated at the 5% probability level ($\alpha = 0.05$), with effects having a *p*-value less than 0.05 considered statistically significant. Where significant overall effects were detected, appropriate post-hoc multiple-comparison procedures were used to determine the specific treatment levels responsible for the observed differences. The statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS).

III. RESULTS AND DISCUSSION

3.1 Results

(a) Sieve Analysis

Figure 1 presents the particle-size distribution characteristics of the river sand and Naka Laterite Rock Finess (NLRF) used as fine aggregates in mortar production. The river sand recorded a coefficient of uniformity (Cu) of 2.09 and a coefficient of curvature (Cc) of 1.00, while NLRF recorded higher values of 3.40 and 1.20, respectively. The higher Cu of NLRF indicates a wider range of particle sizes than the river sand, suggesting greater variation in particle distribution. Although the Cc values of both materials fall within the conventional range of 1.0–3.0, their Cu values are below 6; therefore, neither material can be classified as well graded based solely on the conventional grading criterion. Nevertheless, the relatively higher Cu of NLRF indicates a broader particle-size distribution, which may influence particle packing and void filling in mortar. This observation is consistent with Yaragal et al. (2019), who reported that the grading and processing of lateritic fine aggregates significantly influence their performance in cement-based materials. Similar findings were reported by Obam et al. (2024) and Obam et al. (2025), while Nwogu (2022) noted that Cc values between 1 and 3 generally indicate a favourable particle-size distribution when considered alongside Cu. The fineness modulus (FM) was 2.45 for river sand and 2.23 for NLRF. Since a higher FM indicates relatively coarser aggregate particles (Saberi et al., 2021), the lower FM of NLRF indicates that it was comparatively finer than the river sand. This difference in grading may influence particle packing, water demand and workability of the mortar. The percentage passing the 75 µm sieve was 2% for river sand and 3% for NLRF, indicating relatively low proportions of very fine materials such as silt, clay and dust. These low fines contents suggest that excessive fine materials, which can increase specific surface area and water demand and consequently affect mortar workability, were not present in significant quantities (BS EN 12620, 2013).

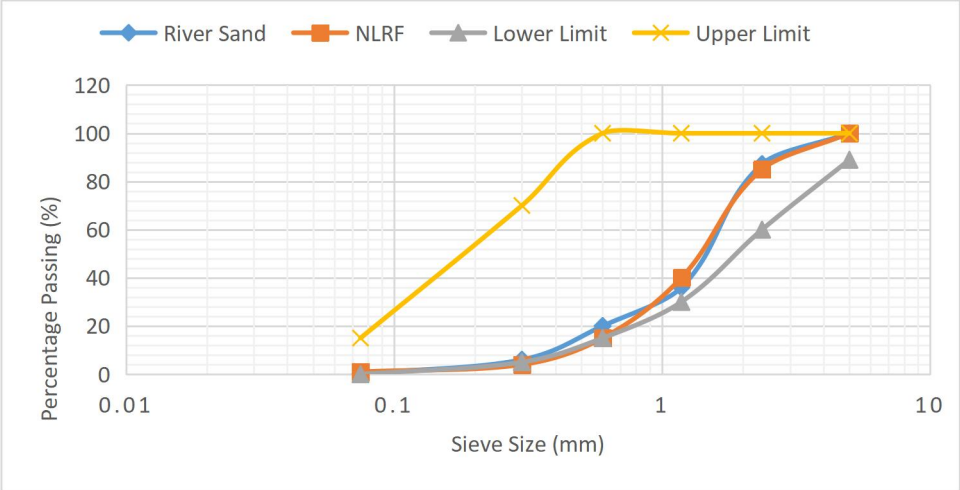


Fig. 1: Grading Curve for River Sand and Naka Laterite Rock Fines

(b) Specific Gravity

The specific gravity values obtained for river sand and Naka Laterite Rock Finess (NLRF), were 2.53 and 2.37, respectively. The values obtained in this study are generally comparable with those reported by Obam et al. (2024), indicating consistency with previous findings on similar aggregate materials.The specific gravity of NLRF (2.37) is relatively close to the value of 2.44 reported by Zaheer et al. (2022). This slight difference may be attributed to variations in the mineralogical composition and source of the laterite materials. The specific gravity obtained for granite (2.62) falls within the range of 2.6–3.0 reported by Neville (1997) and is also consistent with the typical range of 2.6–2.7 for granite aggregates.

(c)Water Absorption of Mortar Cubes

Figure 2 presents the water absorption values of mortar cubes produced with different proportions of Naka Laterite Rock Fines (NLRF) at cement-to-fine-aggregate mix ratios of 1:5 and 1:6. Water absorption is an important indicator of the pore structure and permeability characteristics of cement-based materials because higher absorption generally indicates greater connectivity or volume of capillary pores through which water can enter the hardened matrix. In the present study, water absorption at the 1:5 mix ratio ranged from 7% for the control mortar containing 0% NLRF to 12% at 100% NLRF. At the 1:6 mix ratio, the values ranged from 9% to 12%. Thus, the progressive incorporation of NLRF generally increased the water absorption of the mortar, with the control specimens recording the lowest absorption and the higher replacement levels recording greater absorption. The increase in water absorption with increasing NLRF content may be associated with the physical characteristics of lateritic fines. Lateritic materials can contain relatively porous particles and appreciable quantities of fine or clay-sized constituents, which can increase their capacity to retain water. Yaragal et al. (2019) reported that lateritic fine aggregates exhibited higher water absorption than conventional river sand and attributed this behaviour to the characteristics and porosity of the lateritic particles. The study further emphasized that processing and grading of lateritic fine aggregate are important because excessive fines can influence water demand and the performance of mortar. The present trend is also consistent with the findings of Udoeyo et al. (2006), who investigated

laterized concrete containing 0–100% laterite as replacement for sand. The results showed that percentage water absorption increased with increasing laterite replacement, alongside changes in other strength properties. This was attributed to differences between laterite and conventional sand and demonstrates that increasing laterite content can modify the pore structure and moisture-absorption characteristics of cement-based materials. Similarly, Garba et al. (2024) investigated laterite as a partial replacement for fine aggregate in reinforced concrete and reported that water absorption increased with the incorporation of laterite. Furthermore Nteyoho et al. (2026), identified residual clay constituents in laterite as an important consideration in evaluating the water absorption behaviour of laterized concrete.

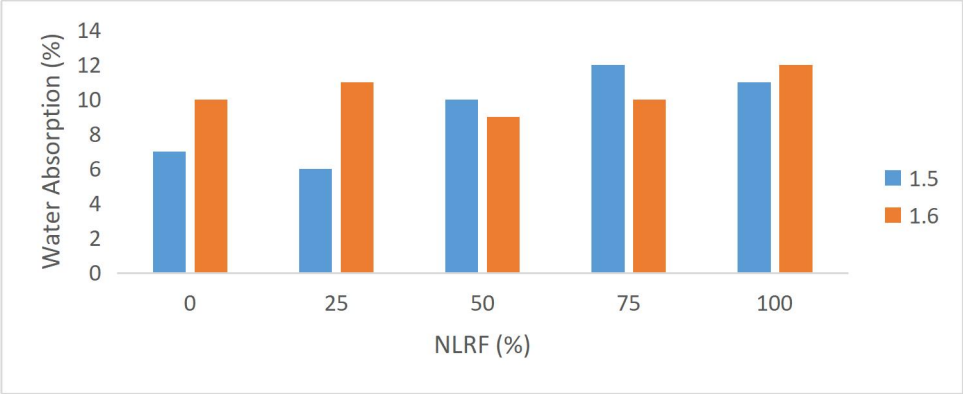


Fig. 2: Water Absorption of Mortar Cubes at Cement-to-fine-aggregate Ratios of 1:5 and 1:6

d) Density of Cubes

Density is an important physical property of mortar because it influences its weight, compactness, durability and suitability for various construction applications. The density values presented in the table show variations with increasing NLRF content for both the 1:5 and 1:6 mix ratios. At 0% NLRF, the density values ranged from 2,233 to 2,582 kg/m³ for the 1:5 mix ratio and from 2,273 to 2,558 kg/m³ for the 1:6 mix ratio. With increasing NLRF incorporation, the density values ranged from 2,233 to 2,298 kg/m³ for the 1:5 mix and from 2,582 to 2,801 kg/m³ for the 1:6 mix ratio. The variations indicate that NLRF influenced the packing characteristics and compactness of the mortar matrix. The observed density behaviour can be attributed to the physical characteristics, particle-size distribution and packing arrangement of NLRF within the mortar. Although the specific gravity of NLRF (2.37) was lower than that of sand (2.53), specific gravity alone does not determine the density of hardened mortar. Particle arrangement, degree of compaction, void content, moisture condition and cement-paste distribution can substantially influence the resulting density. This agrees with the findings of Yehualaw et al. (2025), who reported that the density of laterite soil powder mortar was influenced by both the density and fineness of the incorporated lateritic material. They observed that relatively fine laterite particles could fill pores and improve compactness at lower replacement levels, whereas higher replacement levels could reduce density because of the lower density and porous nature of the laterite soil powder. Similarly, Yaragal et al. (2019) reported that the physical characteristics and particle distribution of processed lateritic fine aggregates influenced the performance of cement mortars and concretes. Awoyera et al. (2017) also investigated mortars produced using laterite and ceramic wastes and demonstrated that the incorporation of alternative fine materials modifies the mechanical and microscale characteristics of mortar. These findings support the view that the density of NLRF-modified mortar should be interpreted in relation to particle packing and matrix structure rather than specific gravity alone.

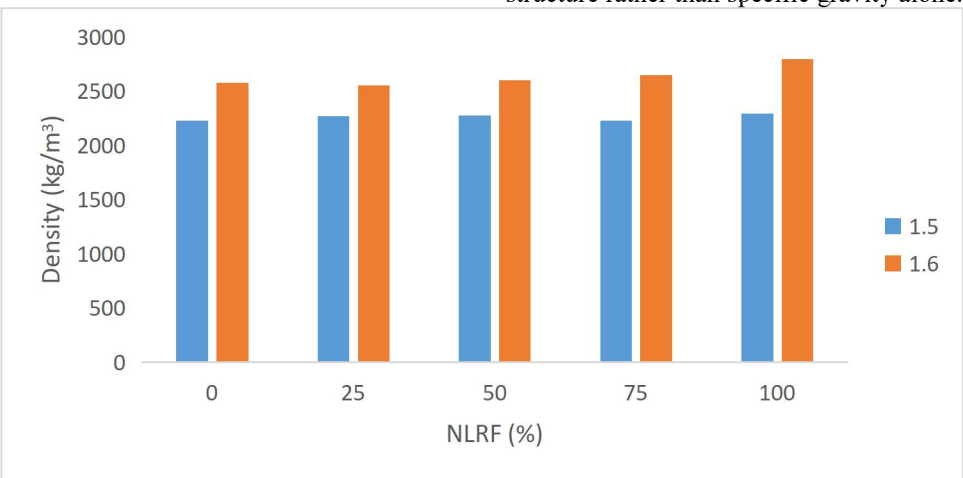


Fig. 3: Density Result of Mortar Cubes at Cement-to-fine-aggregate Ratios of 1:5 and 1:6

(e) Compressive Strength Test

Compressive strength is an important mechanical property of mortar because it indicates its ability to resist crushing loads and is commonly used in assessing the suitability of mortar for structural and masonry applications. The results presented in Figure 4 show that the compressive strength of the mortar cubes varied with NLRF content and mix ratio. The recorded compressive strength values ranged from approximately 12.03 to 15.30 N/mm². The results indicate that the incorporation of NLRF produced both beneficial and adverse effects on compressive strength, depending on the replacement level and mortar mix ratio. At 25% NLRF, compressive strength generally increased relative to the control mixture, whereas further increases in NLRF content to 50%, 75% and 100% resulted in a progressive reduction in strength. This suggests that a moderate quantity of NLRF may improve the packing and bonding characteristics of the mortar, while excessive incorporation may adversely affect the cement–aggregate matrix.

The increase in compressive strength observed at 25% NLRF may be associated with improved particle packing and the filling of voids within the mortar matrix. Fine NLRF particles can occupy spaces between larger sand particles and consequently produce a relatively denser and better-packed matrix. This interpretation is supported by Yaragal et al. (2019), who reported that the grading of lateritic materials significantly influenced the mechanical properties of concrete and that finer lateritic material could improve strength characteristics, similar to the findings of Yehualaw et al. (2025), who investigated laterite soil powder in mortar. They found that incorporation of laterite soil powder up to moderate replacement levels produced only a modest reduction in compressive strength, while higher replacement levels caused a more pronounced decline in strength. In their study, 10% laterite soil powder produced compressive strength statistically comparable with the control, whereas increasing the replacement level resulted in progressively lower strength. The authors attributed the reduction at higher replacement levels partly to changes in density and the characteristics of the laterite material.

The reduction in compressive strength observed at 50%, 75% and 100% NLRF may be associated with the increased proportion of clay and fine particles in the NLRF. Excessive clay and fines can increase water demand and interfere with the effective bonding between cement paste and aggregate particles. The presence of clay in lateritic materials has previously been identified as an important factor affecting the quality and mechanical performance of mortar and concrete. Santha et al. (2022), noted that the clay content and physical characteristics of lateritic materials can significantly influence their suitability as aggregate replacements. Santha et al. (2022) reported that the use of laterite as a partial or complete replacement for conventional fine aggregate can result in changes in compressive strength, depending on the grading and proportion of lateritic material used. The compressive strength values obtained in the present study, ranging from 12.03 to 15.30 N/mm², are above the minimum value stated in BS EN 998-2:2010 for the relevant mortar strength class. Therefore, the tested mixtures achieved compressive strengths exceeding the minimum 6 N/mm² criterion adopted in this study. This indicates that, despite the reduction in strength at higher NLRF replacement levels, the resulting mortars retained sufficient compressive strength for applications where the specified strength requirement is satisfied.

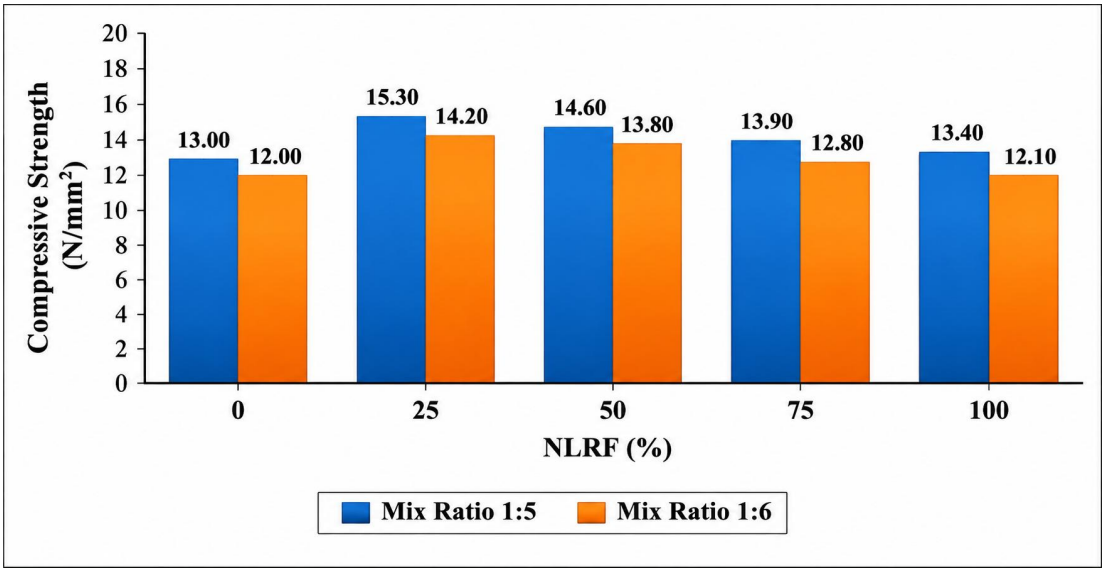


Fig. 4: Compressive Strength of Mortar Cubes

3.7 Statistical Treatment using Two-Way Analysis of Variance

Tables 2 shows descriptive statistics ANOVA of the effects of mix ratio and NLRF percentage on compressive strength. The descriptive statistics showed that NLRF replacement and mix ratio influenced the compressive strength of the mortar. For the 1:5 mix, mean strength increased from 13.00 N/mm² at 0% NLRF to 15.33 N/mm² at 25%, before declining to 14.33, 14.00 and 13.33 N/mm² at 50, 75 and 100%, respectively. For the 1:6 mix, strength increased from 12.00 N/mm² at 0% to 14.00 N/mm² at 25 and 50%, before decreasing to 12.67 and 12.00 N/mm² at 75 and 100%. However, the 1:5 mix recorded a higher mean strength (14.00 N/mm²) than the 1:6 mix (12.93 N/mm²), while 25% NLRF produced the highest overall mean of 14.67 N/mm². The low standard deviations (0.000–0.816 N/mm²) indicate good consistency among the replicate measurements. The ANOVA showed that the overall model was significant, $F(9,20) = 25.667$, $p < 0.001$, with $R^2 = 0.920$, indicating that 92.0% of the variation in compressive strength was explained by the model. Mix ratio had a significant effect, $F(1,20) = 64.000$, $p < 0.001$, $\eta p^2 = 0.762$, while NLRF percentage also had a significant and very large effect, $F(4,20) = 39.625$, $p < 0.001$, $\eta p^2 = 0.888$. The stronger performance of the 1:5 mix may be attributed to its higher cement content, which provides more paste for binding particles and filling voids. Similarly, the improvement at 25% NLRF may indicate that moderate replacement enhanced particle packing and contributed to a denser mortar matrix. However, the interaction between mix ratio and NLRF percentage was not significant, $F(4,20) = 2.125$, $p = 0.115$, $\eta p^2 = 0.298$.

Table 2: Descriptive Statistics of Compressive Strength of Mortar

Mix Ratio	NLRF (%)	Mean (N/mm²)	Std. Deviation	N
1:5	0	13.00	0.000	3
1:5	25	15.33	0.577	3
1:5	50	14.33	0.577	3
1:5	75	14.00	0.000	3
1:5	100	13.33	0.577	3
1:5 Total	—	**14.00**	**0.926**	**15**
1:6	0	12.00	0.000	3
1:6	25	14.00	0.000	3
1:6	50	14.00	0.000	3
1:6	75	12.67	0.577	3
1:6	100	12.00	0.000	3
1:6 Total	—	**12.93**	**0.961**	**15**
Overall	0	12.50	0.548	6
Overall	25	14.67	0.816	6
Overall	50	14.17	0.408	6
Overall	75	13.33	0.816	6
Overall	100	12.67	0.816	6
Grand Total	—	**13.47**	**1.074**	**30**

IV CONCLUSION AND RECOMMENDATION

The study established that Naka Laterite Rock Finess (NLRF) can be used as a replacement for river sand in cement mortar. NLRF had a specific gravity of 2.37 compared with 2.53 for river sand, while its incorporation generally increased water absorption. Compressive strength was significantly influenced by both mix ratio and NLRF percentage ($p < 0.001$). The highest observed mean compressive strength of 15.33 N/mm² was obtained at 25% NLRF replacement with the 1:5 mix ratio, while higher replacement levels generally resulted in reduced strength. The interaction between mix ratio and NLRF percentage was not significant ($p = 0.115$). The study concluded that moderate NLRF replacement produced favourable mortar performance. Based on the findings, NLRF is recommended as a potential fine aggregate replacement in cement mortar, particularly at a 25% replacement level with a 1:5 mix ratio, which recorded the highest observed compressive strength. Higher replacement levels should be used cautiously because of their tendency to increase water absorption and reduce compressive strength. The NLRF should be properly crushed, sieved and processed before use to ensure consistent performance. Further studies should investigate the long-term durability, economic benefits and environmental implications of using NLRF in mortar.

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