



REVIEW ARTICLE

ANALYSIS OF BAMA GRAVEL AS COARSE AGGREGATE IN CONCRETE PRODUCTION: A REVIEW

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ABSTRACT

Bama gravel, a naturally occurring riverbed aggregate in Borno, Northeastern Nigeria, is widely used in concrete production due to its abundance and low cost. This naturally occurring aggregate from Bama ridge, extends over a distance of approximately 300 km. In the past few years, attention has been shifted by researchers to exploring the engineering potential of the aggregate. The review adopted systematic approach by collecting and analyzing studies on Bama gravel between 1999 and 2025. A total of 10 documents were identified, of which seven met the inclusion criteria and were analyzed to identify performance trends and research gaps. The review shows that more than 90% of the studies carried out on the aggregate are by indigenous researchers. This is due to the prior knowledge of these researchers on how the material is being patronized by local communities in the catchment area. The review also shows that existing studies are focused on grading of the aggregate, mix ratio optimization and partial replacement of cement or aggregates, demonstrating its suitability for producing medium and high-strength concrete. However, key research gaps remain, as lack of established probabilistic properties of Bama gravel which are vital for reliability-based design. This limits its global applicability in the design of concrete. Its mineralogical composition is also undocumented, despite its potential impact on reactivity, strength, and durability. Long-term performance under diverse environmental conditions remains unstudied. Furthermore, the microstructural behavior within the cement matrix, including the interfacial transition zone and bonding characteristics, is unexplored. To our knowledge there never been any study that assessed its resistance to Sulphate attack, a critical factor for exposure to aggressive environments. Addressing these gaps will advance the understanding and global acceptance of Bama gravel as a durable and reliable aggregate for concrete production.

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1.0 Introduction

Concrete remains the world's most consumed construction material, its performance depends largely on the characteristics of coarse aggregates, which constitute about 60-75% of its total volume. However, the global construction industry faces growing challenges of aggregate scarcity, sustainability, and cost, especially in developing regions where conventional crushed stones are expensive or inaccessible. As a result, attention has been shifted toward locally available natural aggregates that can substitute conventional material without compromising strength and durability. In this context, Bama gravel, a naturally occurring riverbed aggregate from northeastern Nigeria, has gained significant local importance but remains underexplored in the global research landscape. The performance of concrete is largely dependent on the properties of the aggregates used. For instance, angular aggregates typically provide better interlocking and bond strength with the cement paste compared to rounded aggregates, which may compromise the mechanical integrity of concrete (Mindess et al., 2003).

In Borno and some states in the north eastern part of Nigeria, locally sourced Bama gravel has been in intensive use as coarse aggregate for concrete production. In some cases, this is the only locally available natural coarse aggregates popularly used, because chippings (artificially crushed stone) or other coarser aggregates with a higher diameter are very scarce and costly (Onundi *et al.*, 2003). The name "Bama" is prefixed to the gravel because it is linked to the Barna ridge, which begins in the Cameroon plains, and passes through the northern tip of the Mandara Mountains, and extends approximately 300 km into Nigeria. This ridge comprises granitic rocks of Mubi and Gwoza, and it passes through the Yedzaram River, commonly referred to as the Barna River. Bama gravel is found in large quantities around Bama town and also in surrounding areas such as Madupe, a village located about 75 km southeast of Maiduguri, along the Gwoza-Damboia road. Onundi *et al.* (1999) The gravel is a natural product of the weathering of granitic rocks and is transported to the riverbed by run-off as a result of rainfall and other agents of erosion. It has an average grain size ranging from 2 mm to 10 mm, interspersed with intermediate sizes. The abundance and characteristics of Bama gravel make it a significant locally available material for construction and other civil engineering purposes (Onundi *et al.*, 1999).

Coarse aggregates are the main component of concrete occupying around 45% of the total volume of concrete. Aggregate properties significantly affect the workability of plastic concrete and also the durability, strength, thermal properties, and density of hardened concrete. Cement is the only factory-made standard component. Other ingredient, namely, water and aggregate are natural materials and can vary to any extent in many of their properties. However, the extent of studies required in respect of aggregates to understand their widely varying effects and influence on the properties of concrete cannot be overrated (Zahid *et al.*, 2015). Recently, researchers and construction professionals have advocated for the need to critically analyze indigenous materials to ensure that they meet both local and international building standards. Such analysis contributes not only to safer and more durable infrastructure but also to economic development through the promotion of local resources (Ede and Joshua, 2014). A critical review of Bama gravel usage will help identify its strengths and weaknesses, promote better material selection, and guide policy formulation for quality assurance in the construction sector. In light of the above, this study aims to provide a comprehensive review of researches conducted on Bama gravel in production of concrete.

2.1 Bama Gravel

Several researchers have investigated the suitability and performance of Bama gravel as a coarse aggregate in concrete production (Onundi *et al.* 1999, Onundi *et al.* 2003, Kadai *et al.* 2023, Shittu and Yusuf). For instance, Onundi *et al.* (2003) examined the effects of varying mix proportions and water-cement ratios on the compressive strength of medium-grade concrete incorporating Bama gravel. The study demonstrated that the compressive strength is inversely related to both the water-cement ratio and the fine aggregate content. Consequently, the study also emphasized the need for precise control of mix design parameters to achieve quality concrete. Earlier, Onundi *et al.* (1999) had reported that Bama gravel exhibits a wide particle size distribution ranging from fine to fairly coarse, a characteristic that influences its compaction behavior and overall concrete performance. Furthermore, they classified Bama gravel based on texture, grading, and performance, and found it to be suitable for medium-strength concrete when properly processed and graded. These findings collectively indicate that while Bama gravel has potential as a local material for concrete production, special attention must be given to mix proportioning, particle gradation, and water content to optimize its structural performance. A Proper understanding of these parameters not only ensures economic and environmental benefits but also enhances the structural integrity of concrete made with locally sourced aggregates.

Onundi *et al.* (2019) reported that incorporating waste rubber aggregates into Bama gravel concrete reduces compressive strength but enhances durability-related properties. Using mix ratios of 1:1½:3 and 1:2:4 with water-cement ratios of 0.5 and 0.6, the study found that 20–30% rubber replacement significantly decreased strength, making such mixes unsuitable for structural use. However, they exhibited low water absorption, reduced shrinkage, and high impact resistance, making them more suitable for non-structural applications such as floors, kerbs, and blocks. A 10% fine rubber replacement showed only about a 10% strength reduction, indicating limited structural potential. Onundi *et al.* (2019) investigated the impact of fire exposure on the structural performance of reinforced concrete members made with Bama gravel as the coarse aggregate. The study found that the aggregate had a significant influence on the behavior and the strength retention of medium-grade reinforced concrete when subjected to elevated temperatures.

Kadai *et al.* (2023) investigated the potential of utilizing Bama gravel in combination with bagasse ash as alternative materials in the production of high-strength grade concrete. The study involved experimental testing to evaluate the mechanical performance of concrete incorporating varying proportions of bagasse ash

as a partial replacement for cement. The findings revealed that the inclusion of bagasse ash significantly influenced the compressive strength of the concrete. Statistical analysis confirmed that bagasse ash had a substantial and positive effect on strength development, especially at later curing ages, thereby demonstrating its potential as a supplementary cementitious material. The study concluded that the synergy between Bama gravel and bagasse ash could enhance the performance characteristics of high-strength concrete, promoting the use of locally available materials for sustainable construction.

Kadai *et al.* (2025) produced rapid hardening concrete using locally available Bama gravel and crushed stone with sodium chloride as a partial replacement of cement. The results indicated that NaCl increased the consistency, reduced setting time, and significantly enhanced early compressive strength up to 57.67 N/mm² at 28 days with 4% NaCl. The above studies have investigated the use of Bama gravel as a coarse aggregate in concrete production, particularly within the northeastern region of Nigeria where the material is locally sourced and abundantly available. These studies have primarily focused on evaluating the compressive strength of concrete mixes incorporating Bama gravel in combination with cement, pozzolanic materials such as bagasse ash, and other supplementary cementitious materials. Research by Onundi *et al.* (2003, 2019), Gubio *et al.* (2018), and Kadai *et al.* (2023), among others have consistently demonstrated how variations in mix proportions, water-cement ratios, and partial replacements influence the compressive strength behavior of concrete.

However, a critical observation across all reviewed literature is that the emphasis has been largely placed on the mechanical performance of concrete products, particularly compressive strength, rather than a comprehensive study of the Bama gravel aggregate itself. Properties such as stochastic parameters, mineralogical composition, detailed morphological characterization, durability performance in varying environments, and microstructural behavior remain underexplored.

2.2 Statistical Modeling of Aggregate Properties in Relation to concrete strength

Vu and Ho (2025) conducted a comparative investigation into the probability distribution models for compressive strength of concrete with consideration of size effects, using 360 measured strength values obtained from molded cylinders and cores specimen of varying dimensions. The study assessed three common probability models; normal, log-normal, and Weibull distribution based on maximum log-likelihood and minimum distance criteria. Findings revealed that the normal distribution provided the most reliable fit across different specimen sizes and mix proportions, making it most appropriate model for interpreting both compressive strength and its size dependence. Additionally, results indicated that the specimen size significantly influences both the compressive strength values and their probability distributions. While the size dependence could be interpreted using normal and log-normal distributions, the Weibull distribution was found unsuitable.

Teymen (2023) developed a model to evaluate the effects of different aggregate origins on the mechanical properties of concrete. Practical equations were proposed for the rapid evaluation of concrete properties during preliminary design. Laboratory studies using 20 aggregates with varying origins showed that aggregate properties strongly predict concrete performance, with extremely high coefficients of determination. Sergio *et al.* (2020) studied the probability distributions of mechanical properties of granite and limestone aggregates (9.5–25 mm). Water absorption of 100 individual particles and point load tensile strength were measured, and results were fitted with Weibull distributions. Joanna *et al.* (2020) examined Carpathian sandstone aggregates using Los Angeles fragmentation and Micro-Deval abrasion resistance tests. Statistical fitting showed that the logarithmic function best described the relationship between the two parameters. Leila *et al.* (2016) evaluated 15 statistical models for particle size distribution (PSD) using 2,653 soil samples. The Weibull model was identified as the most accurate across all textural groups. Rozenblat *et al.* (2011) analyzed particle strength distribution under compression and demonstrated that microstructural defects require statistical description, often using Weibull or lognormal models. They introduced an extended logistic function linked to material properties, concluding that accurate particle strength distribution modeling enhances simulation and design reliability. Despite extensive statistical modelling on general aggregate, no probabilistic analysis of the properties of Bama gravel or reliability analysis of members produced with Bama gravel concrete has been established for Bama gravel.

2.3 Effect of Aggregate Origin on Concrete Properties

According to Shittu and Yusuf (2025), the growing need for sustainable and high-performance concrete has intensified research into optimizing locally available aggregates such as Bama gravel, whose inherent weakness particularly its tendency to produce lower compressive strength necessitates performance enhancement

through supplementary cementitious materials. An analytical review of existing studies shows that silica fume, due to its ultrafine amorphous silica content and strong pozzolanic activity, improves concrete microstructure by reducing pore connectivity and increasing the formation of secondary calcium silica hydrate (C–S–H), thereby addressing the mechanical deficiencies associated with Bama gravel. However, benefits are highly dosage-dependent: while 10–15% replacement consistently enhances strength, durability, and impermeability, excessive amounts (>20%) adversely affect workability and may induce microcracking from increased water demand. Overall, current evidence demonstrates that integrating silica fume with Bama gravel is a viable pathway toward producing more durable and structurally reliable concrete, but optimal performance relies on precise proportioning and a critical understanding of microstructural mechanisms rather than descriptive reporting alone.

According to Abubakar *et al.* (2024), concrete produced with Kuta gravel achieved the highest strength at a water–cement ratio (W/C) of 0.4, coarse aggregate–total aggregate ratio (CA/TA) of 0.55, and total aggregate–cement ratio (TA/C) of 3, yielding a compressive strength of 26.8 N/mm². This optimal mix reflects the inverse relationship between total aggregate–cement ratio and compressive strength, as higher cement content results in a denser matrix and improved bonding. The study analytically demonstrated that as TA/C increases, the cement paste becomes insufficient to coat the aggregates effectively, thereby reducing strength. Conversely, at lower TA/C ratios and moderate W/C ratios, the paste fills voids efficiently, improving load transfer and resistance to failure. The mechanical and physical properties of Kuta gravel—including specific gravity (2.60), water absorption (0.60%), flakiness index (26%), elongation index (29%), and aggregate impact value (16.45%)—were all within the limits prescribed by British Standards, confirming its suitability as a natural coarse aggregate for sustainable concrete. Therefore, Abubakar *et al.* (2024) concluded that Kuta gravel can effectively replace conventional crushed stone in structural concrete requiring compressive strengths of up to 25 N/mm², making it a viable and eco-friendly alternative in local construction practices.

Ezeokoli *et al.* (2023) assessed the suitability of locally sourced gravels from Awgu, Enugu Ezike, and Ugwuaji in Enugu State, Nigeria. Thirty-six cubes (150 × 150 × 150 mm) were cast using a 1:1:2 mix ratio and cured up to 28 days. All aggregates exceeded the minimum target strength of 25 N/mm². Awgu gravel achieved the highest average strength (29.26 N/mm²), followed by Ugwuaji (26.30 N/mm²) and Enugu Ezike (25.85 N/mm²). Awgu gravel was recommended for structural applications. Ukpai *et al.* (2024) evaluated the suitability of sandstones from the Afikpo basin in southeastern Nigeria as potential sources of aggregates construction, addressing the challenge of long-distance transportation of chippings despite the availability of nearby rock masses. Petrographic and grain size analysis revealed that the sandstones, predominantly composed of quartz (74–81%) with less than 25% feldspar, are poorly sorted, angular, and exhibit convex/concave grain contents, typical of greywacke sandstones. These characteristics indicate high strength and resistance to stress, making them reliable as coarse aggregate materials for roads and building construction. The study concludes that the Afikpo sandstone are viable alternatives to conventional igneous and metamorphic rocks, contributing to sustainable infrastructural development in the region.

Onundi *et al.* (2003) examined the effects of varying mix proportions and water-cement ratios on the compressive strength of medium-grade concrete incorporating Bama gravel. The study demonstrated that the compressive strength is inversely related to both the water-cement ratio and the fine aggregate content. Consequently, the study also emphasized the need for precise control of mix design parameters to achieve quality concrete.

2.4 Influence of Crushing and Morphology

Fereidooni (2022) found that the texture coefficient (TC) had a stronger correlation with rock mechanical properties than the mineralogy coefficient (MC), with coefficient of determination reaching 0.96 for uniaxial compressive strength (UCS), 0.93 for point load index (PLI) 0.86 for Brazilian tensile strength (BTS) and 0.88 for block punch index (BPI) compared to 0.7, 0.56, 0.72, and 0.55 respectively. The regression and correlation analysis indicate that the mechanical performance of rock is more strongly influenced by their textural characteristics such as grain size, shape, orientation, and degree of interlocking than by mineralogical composition. Using 28 rock samples of igneous, sedimentary, and metamorphic origin, the study demonstrated that dense and interlocked texture significantly enhance compressive and tensile strength, while increased porosity and weaker mineral bonds reduce strength.

Wang *et al.* (2020) developed a stochastic microscopic concrete model to analyze the influence of aggregate geometry and interfacial transition zones on concrete performance. The simulation showed that variation in aggregate shape, grading, and content significantly affect both the mechanical and durability properties of

concrete. Specifically, an increase in aggregate volume fraction enhanced the elastic modulus but reduced poisons ratio. Miskovsky *et al.* (2004) examined the influence of mineralogical composition and textural properties on the quality of coarse aggregates from granitoid rocks in Sweden. Using 17 samples from the Baltic Shield, aggregate quality was evaluated through flakiness, impact value, and two abrasion tests alongside petrographic analyses of mineral composition, grain size, grain boundaries, and micro-crack frequency. The study found that higher feldspar content, finer grains, and irregular grain boundaries improved resistance to mechanical impact, whereas increased mica content and greater micro-crack frequency reduced strength. Abrasion value II was shown to depend more on textural properties than on mineral composition alone.

Statistical modeling confirmed that both mineralogical and microstructural parameters are key predictors of aggregate performance, with practical implications for aggregate production that emphasize limiting deleterious minerals like mica and reducing micro-cracks to enhance construction material quality.

2.5 Aggregate Size and Shape in Concrete

Konitufe *et al.* (2023) studied the effect of six different aggregate sizes (5.0, 6.3, 10, 14, 20, and 25 mm) with angular and rounded shapes on compressive strength. Specimens were cured for 3, 7, 14, 21, and 28 days. Results showed that compressive strength increased with aggregate size up to 14 mm, after which strength declined. The optimum compressive strength at 28 days was 27.58 N/mm² for angular aggregates and 25.88 N/mm² for rounded aggregates, confirming that angular aggregates provide superior strength. According to Abegaz *et al.* (2020), the physical properties of coarse aggregates significantly influence the workability and structural performance of concrete, particularly its compressive and flexural strength. Their study examined four types of coarse aggregates—crushed basalt, crushed marble, river gravel, and surface gravel—collected from areas near Nekemte, Ethiopia. Laboratory tests were conducted to determine the physical properties of each aggregate, and C-25 concrete specimens were prepared following the ACI mix design method. A total of 36 cubes and 12 beams were tested for compressive and flexural strength. The findings revealed that variations in aggregate type and properties led to significant differences in the strength of concrete, emphasizing that aggregate characteristics play a critical role in determining concrete performance. Kalra and Mehmood (2018) reported that coarse aggregate type significantly influences the mechanical properties of concrete, especially in high-strength concretes with water-cement ratios ≤ 0.4 . The study found that in concretes above 40 MPa, the interfacial transition zone (ITZ) and the bond between mortar and aggregate become critical, often comparable to aggregate strength, making aggregate selection a vital factor for optimizing strength, durability, and overall performance in structural applications

2.6 Alternative Aggregates for Sustainable Concrete

Le *et al.* (2023) examined the use of sea sand as fine aggregate, focusing on chloride ion contamination. Sea sand with high chloride content (0.375%) reduced slump, increased water demand, and compromised long-term durability due to reinforcement corrosion. Washed sea sand (0.024–0.05% chloride) achieved performance comparable to river sand, emphasizing the necessity of desalting for durability. Tawfik *et al.* (2023) explored heavyweight self-compacting concrete using barite as a partial replacement for natural coarse aggregates. The results showed that while barite slightly reduced fresh and hardened properties, mixes satisfied EFNARC requirements and exhibited improved resistance to sulphate attack and structural stability under elevated temperatures. Microstructural analyses confirmed barite's beneficial effects, demonstrating its potential for producing durable, high-density concrete.

Concrete performance is strongly governed by aggregate properties, which can be effectively modelled using statistical tools. Local aggregates, when properly characterized, can achieve structural-grade concrete, reducing dependence on imported materials. Optimization of aggregate size, shape, and crushing processes further improves concrete strength and durability. Sustainable alternatives like sea sand (when desalinated) and barite offer promising pathways for addressing resource scarcity and enhancing durability under aggressive environments. Overall, integrating statistical modelling, material characterization, and sustainable aggregate utilization provides a holistic approach to advancing concrete technology.

3. Method

The methodology followed in this review is summarized in this subsection as;

3.1 Data and Inclusion Criteria

The review followed clearly defined criteria to ensure transparency and reproducibility. Google scholar was used as the primary database for sourcing literature, with searches limited to publications between 1999 and

2025. The search terms included combinations of. “Bama gravel concrete,” “Bama ridge aggregate,” “Bama gravel compressive strength,” “alternative aggregate Bama gravel,” “engineering properties of Bama gravel,” and “Bama gravel in structural concrete.” The inclusion criteria comprised studies that (i) investigated the engineering properties of Bama gravel when used as coarse aggregate in concrete and (ii) presented direct experimental results on concrete strength, such as compressive, tensile, or flexural strength of concrete produced with Bama gravel. In contrast, the exclusion criteria covered studies that did not deal directly with concrete, particularly those focusing on strength of blocks, stabilization, soil characteristics, or non-concrete application of Bama gravel. Based on these criteria, seven articles were included because they directly addressed the strength performance of concrete containing Bama gravel, while the three articles were excluded for focusing on unrelated applications.

3.2 Data Organization and Presentation

The data are organized based on six types; author and year, title, the aim, methodology, major findings and critics of the surveyed articles (see Table I). Attempts were made to find the perceived research gaps which are presented in the subsequent sections.

Table I: Summary of reviewed articles

Author(s) and Year	Title/Study Focus	Objective/Research Focus	Methodology	Key Findings	Critics
Onundi, L. O., Izam, Y. D., and Umar, S. G. (1999)	The categorization and assessment of local aggregate, Bama gravel for production of a medium grade concrete.	To categorize Bama gravel based on particle size distribution and engineering properties in order to assess its suitability as coarse aggregate in concrete production.	Gravel samples were collected from various Bama gavel deposit around Borno state, the sample were subjected to laboratory tests following BS standard, which, include sieve analysis, AIV, ACV, and S.G.	Bama gravel exhibited a diverse particle size distribution ranging from fine to fairly coarse aggregate, Bama gravel can be used for medium-grade concrete.	The study lacked statistical reliability analysis data (e.g., standard deviation, coefficient of variation) to support the consistency of the work
Onundi, L. O., Yadima, S. G., and Sanyaolu, B. O. (2003)	The effect of varied mix proportion and water-cement ratio on the compressive strength of medium grade concrete produced from Bama gravel	To evaluate the compressive strength of concrete using Bama gravel with varying mix proportions and w/c ratios	Experimental design with different mix ratios and water-cement ratios; compressive strength tested at 7, 14, and 28 days	Optimal strength (28.00 N/mm ²) achieved at 1: ½:4 mix and 0.55 w/c ratio; strength decreases with increasing fine aggregates and water	Limited sample size and scope. Does not consider the effects of curing conditions and environmental exposure
Gubio, A. T., Onundi, L. O., and Balami, Y. G. (2018)	Assessment of the Properties of Rubberized Bama Gravel Concrete using Destructive Method	To assess the mechanical properties of concrete made with varying percentages of rubber as aggregate replacement	Experimental study using destructive testing methods with varying rubber content (10%, 20%, 30%) replacing fine and coarse aggregates; concrete tests included compressive strength,	Rubberized concrete has lower compressive strength but good water resistance and high impact resistance. Only 10% fine rubber replacement is structurally usable.	The study lacks long-term durability assessments and does not evaluate non-destructive testing methods Potential chemical interaction between rubber and cement not explored.

			workability, and density		
Onundi, L. O., Oumarou, M. B., Alkali, A M. (2019)	Effects of fire on the strength of reinforced concrete structural members	To investigate the impact of fire and cooling methods on concrete structural elements	Reinforced concrete samples exposed to simulated fire (900°C), cooled by air, water, or CO ₂ , and tested via destructive and non-destructive methods; SEM imaging used	Compressive strength reduced by 37.73% to 86.67% after fire; cooling method significantly affects strength retention and microstructure	While SEM gives good insights, study doesn't explore the recovery behavior of concrete post-fire or reinforcement degradation
Kadai, B., and Muhammad S. I. (2023)	Suitability of Bama Gravel Aggregate and Bagasse Ash for the Production of Medium-Grade	To assess the effectiveness of SCBA as a partial cement substitute using local aggregates	Experimental study with SCBA (up to 20%) replacing cement; XRF used for chemical analysis; compressive strength tested at 7, 14, and 28 days; ANOVA used.	Best result at 10% SCBA achieving 21.20 N/mm ² at 28 days; SCBA significantly influences strength development; conforms to pozzolanic standards	Focused only on strength; does not evaluate durability, permeability, or resistance to environmental factors like sulphates or chlorides
Kadai, B., Onundi, L. O., and Is'haq, M. I. (2025)	Production of Rapid Hardening Concrete Using Local Aggregate and Sodium Chloride as Partial Replacement of Cement	To improve early strength development of concrete using NaCl as cement partial replacement	Laboratory experiments using 90 cubes with NaCl (1-4%) added, mix	NaCl enhances early strength and consistency concrete produced with Bama gravel, but risk of corrosion in prestressed concrete; best result at 4% NaCl	Risk of chloride-induced corrosion is acknowledged but not fully investigated over the long term. Corrosion tests on reinforcement are absent
Shittu, N. J., and Yusuf, H. (2025)	Investigating the impact of silica fume on the engineering properties of concrete with Bama gravel as the coarse aggregate	To evaluate how varying proportion of silica fume influences the strength, durability, and workability of Bama gravel concrete	Experimental tests on mixes with 0-20% silica fume; slump, permeability, and compressive strength tested at 7, 14, and 28 days	15% silica fume gave optimal strength and durability; excessive silica fume reduced workability and often no addition benefit	Limited mechanical assessment, small sample size; long term durability not explored

4.2 Findings of the Study

The study revealed that concrete produced with Bama gravel exhibited a density of 2385 kg/m³ at 28 days, corresponding to a highest compressive strength of 28 N/mm² at a mix proportion of 1:1 $\frac{1}{2}$:4 and a water-cement ratio of 0.55. The mean values of the aggregate properties were found to be a specific gravity (S.G.) of 2.6, silt content of 2.34%, aggregate impact value (AIV) of 25.5%, and aggregate crushing value (ACV) of 25.11%, with a maximum aggregate size of 10mm.

It was observed that all the results fall within the recommended limits of the relevant standards and codes of practice (BS 882EN 12620). Specifically, the silt content is below the maximum limit of 3%, the specific gravity range (2.5-3.0) is acceptable for natural aggregates, and both the AIV (45%) and ACV (45%) are within permissible limits for structural concrete. Based on the achieved compressive strength, Bama gravel concrete

can be classified as medium-grade concrete (20N/mm²-40N/mm²). These results collectively were indication that the Bama gravel is suitable for use as coarse aggregate in structural concrete production.

4. Conclusion

The review established that Bama gravel is a suitable and sustainable local material for the production of concrete of medium-grade concrete, achieving a compressive strength of 28N/mm and a density of about 2,385 kg/m³ at 28 days. The aggregate's specific gravity 2.6, silt content 2.34%, aggregate impact value 25.5%, and aggregate crushing value 25.11% all fall within acceptable standards. While its performance indicates high potential for structural use, gaps remain in understanding its mineralogical composition, durability, material's stochastic properties, and microscopic behavior. Establishing national standards and promoting its application can support

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