UNIZIK JOURNAL OF AGRICULTURAL AND BIOSYSTEMS ENGINEERING

Journal homepage: https://journals.unizik.edu.ng/ujabe/

UJABE

April (2026), 1(2): 75-85

ISSN: 3141-2912

INFLUENCE OF COARSE AGGREGATE SHAPES ON THE WORKABILITY AND STRENGTH OF CONCRETE

[1]Alabadan B. A., [2]Ajayi E. S., [3]Fabunmi A. O., [3]Usman Y. [3]Obasa P. A. and [4]Alabadan O. F.

[1]Department of Agricultural and Bioresources Engineering, Federal University Oye–Ekiti, Nigeria

[2]Department of Agricultural and Biological Engineering, University of Florida, Florida, USA

[3]Department of Agricultural and Bioresources Engineering, Federal University of Technology, Minna.

[4]Department of Civil Engineering, Obafemi Awolowo University, Ile-Ife, Nigeria.

**Corresponding Author's E-mail: babatope.alabadan@fuoye.edu.ng*

Received: 31st January 2026; **Accepted:** 4th February 2026; **Available Online:** 30th April 2026

ABSTRACT

This study investigated the effect of coarse aggregate shape on the compressive strength and density of concrete. Five aggregate types—angular, elongated, smooth rounded, flaky, and a control mix—were used to cast 60 concrete cubes using a 1:3:6 mix ratio and a water-cement ratio of 0.5. The cubes were cured for 7, 14, 21, and 28 days, after which their average compressive strength and density were determined. The results showed that compressive strength for all aggregate types increased with curing age. The control aggregate produced the highest strength values, reaching 26.01 N/mm² at 28 days, followed by angular and flaky aggregates, which achieved 18.28 N/mm² and 18.16 N/mm² respectively. Elongated and smooth rounded aggregates yielded lower 28-day strengths of 16.36 N/mm² and 16.98 N/mm². Density measurements also varied with aggregate shape and curing time, ranging from approximately 2099 kg/m³ to 2432 kg/m³. The study concludes that aggregate shape significantly influences concrete properties, with angular and control aggregates providing superior compressive strength compared to other shapes.

Keywords: Aggregate, Concrete, Properties, Shape, Strength

1.0 INTRODUCTION

Aggregates typically comprise over 70% of concrete's volume (Mohammed et al., 2009; Islam et al., 2025), making their physical properties—especially those of coarse aggregates—a critical determinant of compressive strength (Alabadan et al., 2015; Macginley & Choo, 2003). Strength hinges on factors like water-cement ratio, grading, surface texture, shape, and maximum size (Building Research Institute, BREINS Engineering, 2015). In normal-strength concrete, failure often stems from cement paste segregating from aggregates (Ezeldin & Aitcin, 1991). Segregation weakens homogeneity and durability (Shetty, 2005), manifesting as aggregate settling or water rising. Causes include raking (Garber, 2006), low water-cement ratios (Saeed et al., 2005), or high water-to-binder ratios (Nawy, 2005). Slump tests reliably indicate segregation risk (Shetty, 2005; Ayhan & Gökçe, 2012). Recent studies affirm shape's pivotal role. Li et al. (2026) showed angular aggregates reduce workability, while spherical shapes boost flowability by 20-30%. Zhang et al. (2025) linked irregular shapes to brittle failure. Ahmed et al. (2025) and Nowak et al. (2026) found elongated aggregates cut strength by 10-25%. Chen et al. (2025) confirmed non-spherical shapes slash slump by 15-40%. Optimized shapes yield gains: cubical forms enhance rheology, enabling 10-15% cement savings (Martinez et al., 2025); spherical slag boosts ultra-high-performance concrete strength by 20% (Park et al., 2025). Angular morphology weakens interfacial zones (Chen & Li, 2025), while rounded sands excel in self-compacting concrete (Singh et al., 2026). Other findings include strength with 50% brick replacement (Alrashidi & Almutairi, 2024), recycled aggregates outperforming natural sands (Bashir et al., 2023), and size effects favouring 16 mm aggregates (Ezenweke, 2022).

This study investigates how coarse aggregate shape, surface texture, and type (natural vs. crushed) affect workability and compressive strength in non-reinforced concrete.

2.0 MATERIALS AND METHODS

2.1 Materials

The materials used for this experiment includes both natural and crushed granites, fine aggregate, Ordinary Portland Cement, water and wooden mould. Crushed granites were obtained from Maitunbi local quarry, Minna and Soject Quarry at Tungan Mallam in Niger State while the natural gravels were obtained from Rabah, Sokoto South, Sokoto State. Also, the fine aggregate and water were obtained from Federal University of Technology, Minna.

2.2 Methods

2.2.1 Sample Preparation

The coarse aggregates were sorted manually. The crushed aggregates were classified into angular, elongated and flaky (BS 8500, 2023) while the natural aggregates as smooth rounded (BS 882, 1992). The control aggregates consisted of a heterogeneous mixture of all shape classifications—angular, elongated, flaky, and smooth rounded particles—in approximately equal proportions. The size of the fine aggregate ranges from 425 µm to 75 µm (BS 8500, 2023) and it was ensured to be free from clay, silt, and other impurities. Wooden mould of 150 mm x 150 mm x 150 mm was used. The moulds were lubricated using spent engine oil to reduce stickiness between the concrete and the wood and eases the removal of the cubes.

Tests: The properties that were determined are contained in Table 1. The sphericity and roundness ratio were determined using equations 1 and 2 respectively.

Sphericity = $(bc/a^2)^{1/3}$ (1); where a = length, b = width, and c = thickness

Roundness ratio = ${}^{r}/_{R}$ (2); where r = radius of curvature of the sharpest corner and R = mean radius.

2.2.2 Concrete Cubes Casting and Curing.

A nominal mix ratio of 1:3:6 was adopted, with a constant water-cement (w/c) ratio of 0.5 maintained throughout the experiment. Workability tests, including slump and compacting factor tests, were conducted on the fresh concrete. The concrete cubes were cast by filling each mould in three layers, with each layer tamped 25 times using a tamping rod to ensure proper compaction. The surface was then levelled and smoothed using a hand trowel. A total of 60 concrete cubes were produced and marked for identification shortly after casting.

Table 1: Tests performed

S/N	PROPERTIES		METHOD/STANDARD	DESCRIPTION
1	Physical	Sieve analysis	BS 812-1	Particle size distribution
		Fineness Modulus (FM)	Calculated from sieve analysis	Sum of cumulative percentages retained on standard sieves ÷ 100
		Coefficient of uniformity (Cu)	Calculated	indicates gradation spread
		Coefficient of curvature (Cc)	Calculated	$(D_{30})^2/(D_{10} \times D_{60})$ – indicates gradation shape
		Sorting coefficient (So)	Calculated	$\sqrt{(D_{75}/D_{25})}$ – indicates particle size variability
2	Density and Specific gravity	Loose Bulk	BS 812-2	Mass per unit volume of aggregate in loose state
		Compacted Bulk	BS 812-2	Mass per unit volume after vibration/compaction
		Specific gravity	BS 812-2	Ratio of aggregate density to water density
3	Moisture Related	Natural	BS 812-1	Water present in aggregate as received
		Water absorption	BS 812-2	Capacity to absorb water (% of dry mass)
4	Mechanical	Aggregate Impact Value (AIV)	BS 812-112	Resistance to sudden shock/impact
5	Shape	Sphericity	Calculated (Equation 1)	measures how close to a sphere
		Roundness ratio	Calculated (Equation 2)	r/R – measures sharpness of corners
		Number of faces, (f)	Visual/manual count	Flat surfaces on particle
		Number of edges, (e)	Visual/manual count	Intersection lines between faces
		Number of corners, (c)	Visual/manual count	Points where edges meet
6	Voids	Porosity	Calculated from specific gravity and bulk density	Volume of pores within particles
		Void ratio	Calculated from bulk density	Volume of voids between particles

The cubes were allowed to set and harden for 24 hours, after which they were gently demoulded and transferred to a curing tank. Curing was carried out by complete immersion in water for a maximum period of 28 days. Compressive strength tests were performed at 7, 14, 21, and 28 days to assess strength development over time.

3.0 RESULTS AND DISCUSSION

3.1 Gradation of the Aggregates

The total aggregates obtained from each sample ranges between 70 - 80 percent of the required shape as shown in Table 2 (Mohammad et al., 2009).

Table 2: Coarse Aggregates' Shape Classification

Typical Shapes	No. of faces (f)	No. of edges (e)	No. of corners (c)
Angular	4 – 8	6 – 14	6 – 12
Flaky	2 – 6	3 – 9	3 – 8
Elongated	3 – 6	4 – 9	4 – 8
Cubical	5 – 6	11 – 12	7 – 8
Irregular	3 – 5	4 – 10	4 – 9
Flaky & Elongated	2 – 5	3 – 9	3 – 8
Smooth rounded	Round	Nil	nil

The physical parameters of aggregates derived from the particle size distribution analysis are presented in Table 3.

Table 3: Gradation of Aggregates Used

Aggregates	Fineness modulus (FM)	Coefficient of uniformity (Cu)	Coefficient of curvature (Cc)	Sorting coefficient (So)	Observation
Fine aggregate	4.2130	2.7143	1.3714	1.6183	Finest, best uniformity
Flaky	5.8696	1.5000	1.0417	1.1649	Coarse, poor gradation
Elongated	6.1965	1.5000	1.0099	1.2649	Very coarse, gap-graded
Angular	6.6086	1.6000	1.1000	1.1698	Coarsest, low variability
Smooth Rounded	6.4328	1.8333	1.0947	1.2748	Moderate sorting
Control	6.3663	1.6429	1.0062	1.2127	Baseline; coarse, narrow

The particle size distribution analysis (Table 3) reveals critical insights into the expected performance of the concrete mixes. The fine aggregate, with a Fineness Modulus (FM) of 4.213, is notably outside the typical range for concrete sand (2.3-3.1), suggesting it could produce a harsh mix with potential bleeding issues, as noted by Shetty (2005). However, its superior Coefficient of Uniformity (Cu = 2.71) and Sorting Coefficient (So = 1.62) indicate a well-graded material, which is fundamental for achieving good packing density and reducing void content. Also, the shaped coarse aggregates (flaky, elongated, angular) exhibit FM values between 5.87 and 6.61, classifying them as very coarse. Their low Cu values (~1.5) and Cc values approaching 1.0 indicate uniformly graded or gap-graded materials. This aligns with the concerns raised by Park et al. (2025) regarding the importance of optimized gradation. Such gradation leads to poor particle interlock and high void ratios in the dry state, which would typically demand more cement paste to fill the spaces, potentially increasing cost and reducing workability. The control aggregates achieve a slightly improved Cu and Cc, suggesting a more balanced particle size distribution that mitigates some of these packing issues. The findings of Mohy (2023) corroborate this, stating that while improving gradation can hinder workability, it is essential for increasing compressive and flexural strength.

3.2 Sphericity and Roundness Ratio

The summary of the average sphericity and roundness ratio for twenty different samples of different types of coarse aggregates used are presented in Figure 1.

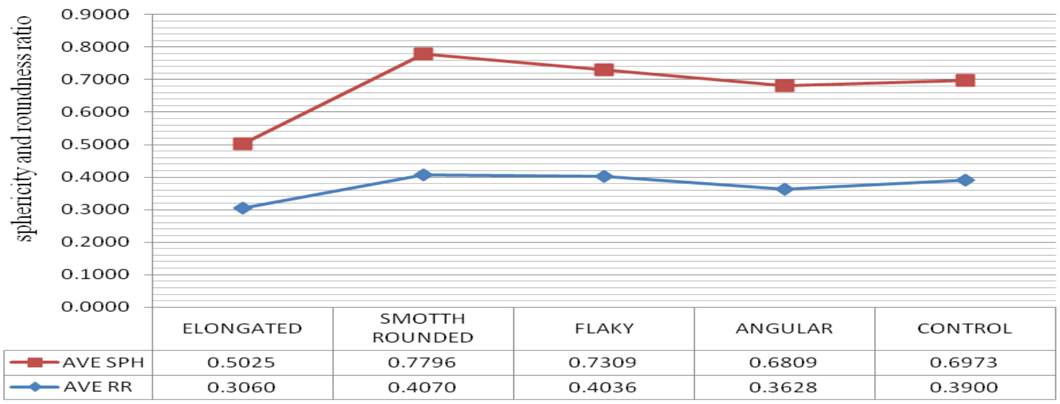

Figure 1: Sphericity and roundness ratio against Aggregate shape

The morphological analysis shown in Figure 1 confirms a strong inverse relationship between shape irregularity and both sphericity and roundness. The smooth rounded aggregates, with their high sphericity and roundness, possess the lowest specific surface area. This characteristic reduces the water demand for a given workability but, as Ahmed et al. (2025) and Nowak et al. (2026) demonstrated, compromises the mechanical bond with the cement paste. This is because the smooth surfaces lack the mechanical interlocking points necessary for a robust interfacial transition zone (ITZ). Equally, the angular and flaky particles, with low sphericity and roundness, present a high surface area and numerous sharp edges. This morphology is directly linked to the findings of Li et al. (2026) and Zhang et al. (2025), who used DEM simulations to show that such irregular shapes increase internal friction and interlocking. While this reduces workability, it is precisely this mechanism that enhances stress transfer from the cement matrix to the strong aggregate particles, leading to higher compressive strength. The elongated particles, exhibiting the lowest sphericity, represent the extreme case of this irregularity, creating potential weak planes within the concrete matrix as noted by Ahmed et al. (2025).

3.3 Aggregates' Natural Moisture Content and Water Absorption.

The aggregates' natural moisture content and water absorption are presented in Table 4.

Table 4: Aggregates Natural Moisture Content and Water Absorption

S/N	AGGREGATE TYPES	MOISTURE CONTENT (%)	AGGREGATE WATER ABSORPTION (%)	Observation
1	Fine Sand	1.13	7.94	Wettest, highly absorbent
2	Flaky	0.18	0.63	Driest, lowest absorption
3	Elongated	0.19	0.84	Low moisture, moderate absorbent
4	Angular	0.19	0.72	Consistent low values
5	Smooth Rounded	0.16	1.04	Lowest moisture
6	Control	0.19	0.65	Baseline; efficient

The water absorption values are a key indicator of aggregate quality and its potential impact on concrete durability. The low absorption of the shaped aggregates (0.63-1.04%) classifies them as having high resistance to weathering and volume changes, as per standard specifications. This is in stark contrast to the fine sand, which, with an absorption of 7.94%, is highly porous. This high porosity, as explained by Shetty (2005), would necessitate a significant correction to the mix water to maintain the desired w/c ratio. Failure to do so would result in a lower effective w/c ratio at the ITZ, potentially leading to unhydrated cement particles and a weaker bond, thus reducing strength. Furthermore, the high absorption could lead to shrinkage and cracking over time. The control aggregate's moderate absorption (0.65%) reflects its mixed composition, offering a balance between durability and water demand, aligning with the balanced profile recommended in standard practice.

3.4 Bulk Density and Specific Gravity of the Aggregates.

The result of the bulk density and specific gravity tests of the aggregates used are presented in Table 5. The physical and mechanical properties in Table 5 provide a robust explanation for the concrete strength results. The low compacted bulk density of the angular and elongated aggregates (1515.63 and 1473.79 kg/m³) is a direct consequence of their poor particle packing and high void content, as indicated by their gradation parameters. This aligns with Wang et al. (2025), who validated that cubical shapes (as opposed to elongated or angular) minimize voids. However, the superior 28-day strength of the angular aggregate concrete demonstrates that mechanical interlocking can overcome lower initial packing density.

Table 5: Bulk Density, Specific Gravity and Aggregate Impact Values of Aggregates used.

S/N	AGGREGATE TYPE	BULK DENSITY (Kg/m³)		SPECIFIC GRAVITY	AGGREGATE IMPACT VALUE	Observations
		UNCOMPACTED	COMPACTED			
1	Fine Sand	1487.43	1588.07	2.55	-	Good packing, no AIV data
2	Flaky	1505.50	1552.50	2.67	5.18	Toughest shaped, low compact
3	Elongated	1422.18	1473.79	2.55	6.35	Lowest densities
4	Angular	1422.18	1515.63	2.62	7.83	Poor uncompacted packing
5	Smooth Rounded	1509.73	1605.40	3.04	8.52	Best compaction, dense
6	Control	1488.91	1595.45	2.52	9.92	Toughest, strong baseline

The Aggregate Impact Value (AIV) is particularly revealing. While Ezeldin and Aitcin (1991) noted that failure in normal-strength concrete involves paste-aggregate separation, the AIV indicates the aggregate's own resistance to fracture. The flaky aggregate, despite showing high late-age strength, has the lowest toughness (highest AIV) among the shaped aggregates. This suggests that in a high-strength matrix or under dynamic loading, the aggregate particles themselves could fracture, becoming the weak link, a mechanism supported by the compressive failure analysis of Zhang et al. (2025). The control aggregate has the highest toughness (lowest AIV), meaning it is most resistant to breakdown. This inherent strength of the particles, combined with the optimized matrix of the control mix, synergistically contributes to its superior compressive strength.

3.5 Workability of Concrete Mixture (Slump Test/ Compacting Factor Test).

The workability results in Table 6 and Figure 2 vividly illustrate the rheological impact of aggregate shape. The angular aggregate concrete exhibited the highest slump (42 mm), which, while seemingly counterintuitive, can be attributed to its very coarse and uniformly graded nature (high FM, low Cu). With fewer fine particles to fill voids between large angular pieces, the mix may have a higher initial free water content, manifesting as a higher slump. However, its high compacting factor (0.94) indicates good mobility under vibration, which is the typical condition for placing such a mix.

Table 6: Workability of Concrete Mixture (Slump Test/ Compacting Factor Test).

Sample	Slump (mm)	Compacting Factor	Observation
Control	41.00	0.91	Balanced baseline
Angular	42.00	0.94	Most workable, easiest compact
Elongated	39.00	0.97	Stiffest slump, best compaction
Smooth Rounded	41.00	0.93	Good flow, moderate compact
Flaky	37.00	0.88	Least workable, stiffest

(a) (b) (c) (d) (e)

Figure 2: Slump Test

(a) Slump Test of Angular Aggregate
(b) Slump Test of Flaky Aggregate
(c) Slump Test of Elongated Aggregate
(d) Slump Test of Smooth rounded Aggregate
(e) Slump Test of Control Aggregate

This behavior is consistent with the findings of Chen et al. (2025), whose DEM study demonstrated that while non-spherical aggregates elevate internal friction, their content and gradation significantly influence the overall flow performance. In this case, the angular particles' high FM dominates the fresh properties. Conversely, the flaky aggregate produced the stiffest mix (slump 37 mm, CF 0.88). This directly supports the conclusions of Li et al. (2026) and Chen and Li (2025), who linked angular and flaky morphologies to reduced workability due to increased particle interlocking and friction. The flat surfaces of flaky particles have a high surface area and tend to align, creating resistance to flow. The elongated aggregate, despite having a lower slump than angular, achieved an exceptionally high compacting factor (0.97). This suggests that while its shape resists gravitational flow (slump), its geometry allows for efficient reorientation and packing under the energy of vibration, a nuance captured by the findings of Singh et al. (2026) regarding the dominance of shape over texture in flow control. The control mix, with its balanced morphological characteristics, provides a benchmark for good all-around workability, echoing the benefits of optimized particle shapes found by Martinez et al. (2025).

3.6 Compressive Strength Test of Concrete Cubes.

Table 7 presents mechanical properties of concrete cubes made from Control, Angular, Elongated, Smooth Rounded, and Flaky and tested at 7, 14, 21, and 28 days, tracking weight, density, crushing load, and compressive strength.

Table 7: Compressive Strength Tests of Concrete Cubes.

Days	Aggregate Shape	Average Weight (kg)	Average Density (kg/m^3)	Average Crushing Load (kN)	Average Compressive Strength (N/mm^2)	Observation
7	Control	8.09	2396.05	395.00	17.56	
	Angular	7.43	2202.47	287.67	9.48	
	Elongated	7.09	2099.75	209.00	9.08	
	Smooth Rounded	7.47	2206.42	204.00	9.01	
	Flaky	7.93	2350.62	225.33	10.01	
14	Control	7.92	2347.65	479.33	21.30	
	Angular	7.23	2141.23	255.67	11.36	
	Elongated	7.11	2105.68	225.00	10.00	
	Smooth Rounded	7.43	2202.47	238.67	10.61	
	Flaky	7.77	2303.21	270.00	12.00	
21	Control	8.21	2431.60	536.00	23.82	
	Angular	7.79	2307.16	326.33	14.50	
	Elongated	7.88	2334.81	292.67	13.01	
	Smooth Rounded	7.66	2269.63	297.33	13.21	
	Flaky	7.92	2346.67	340.00	15.11	
28	Control	8.18	2422.72	585.33	26.01	Strongest overall
	Angular	7.84	2322.96	411.33	18.28	Good progression
	Elongated	8.21	2431.60	368.00	16.36	Moderate strength
	Smooth Rounded	8.04	2382.22	382.00	16.98	Steady gains
	Flaky	8.07	2392.10	408.67	18.16	Late strength surge

Average weight and density indicate specimen mass and compactness; higher values suggest better material packing, with Control consistently densest (~2400 kg/m^3). Average crushing load measures failure force, while compressive strength (N/mm^2) calculates stress at failure—target >20 N/mm^2 at 28 days for structural concrete, improving with curing as hydration advances. Control outperforms all at every age (26.01 N/mm^2 at 28 days), ideal for high-load applications due to superior gradation and toughness from prior tables. Flaky and Angular show promise (18+ N/mm^2), catching up post-14 days despite shape flaws, while Elongated/Smooth Rounded lag (~17 N/mm^2), linking to poor uniformity (low Cu/Cc). All exceed 15 N/mm^2 by 28 days but blend shaped types with Control for optimized durability and workability. Compressive strength development provides the ultimate validation of the aggregate shape's influence. The control mix's superior performance at all ages (26.01 N/mm^2 at 28 days) confirms that a heterogeneous mixture of shapes can achieve an optimal balance of particle packing, ITZ quality, and internal stress distribution. This aligns with the overarching theme of the review by Chen and Li (2025), which links aggregate morphology to the ITZ and overall durability.

Among the single-shape aggregates, angular and flaky performed best. The angular aggregate's high 28-day strength (18.28 N/mm²) is a testament to the mechanical interlocking mechanism described by Li et al. (2026) and Zhang et al. (2025). Despite poor dry packing, the interlock provides numerous strong contact points within the hardened matrix, effectively resisting compressive loads. The flaky aggregate's strong late-age strength (18.16 N/mm²) is more complex. Its high compacted density in the concrete cubes suggests that under vibration and compaction, the flat particles may orient in a way that achieves good packing. However, the potential for these particles to act as weak planes under tensile or flexural stress, as warned by Ahmed et al. (2025), remains a concern not captured by compressive testing alone. The smooth rounded aggregate, despite its high specific gravity and compacted bulk density—indicating good packing—yielded lower strength (16.98 N/mm²). This directly corroborates the findings of Ahmed et al. (2025) and Nowak et al. (2026). The smooth surfaces prevent the formation of a strong mechanical bond with the cement paste. Failure likely occurs along the ITZ, the "weakest link" as per Chen and Li (2025), rather than through the aggregate or paste itself.

The elongated aggregate's consistently lowest strength (16.36 N/mm²) confirms that its shape is highly detrimental. Its poor sphericity likely creates a "fiber-like" orientation that can act as a stress concentrator and create zones of poor paste consolidation around its longest axis, leading to premature cracking. This performance validates the machine learning predictions of Ahmed et al. (2025) that elongated particles slash compressive and tensile strength.

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

Aggregate shape directly influences packing density, workability, and the quality of the interfacial transition zone (ITZ), which in turn dictates compressive strength. Irregular shapes (angular, flaky) enhance mechanical interlocking and stress transfer, leading to higher strength, while rounded shapes improve packing and workability but compromise the ITZ bond. The control mix, comprising a blend of all shapes, consistently outperformed all single-shape aggregates in compressive strength and exhibited balanced workability.

4.2 Recommendations

A blend of crushed (angular) and natural (rounded) aggregates should be utilized to harness the benefits of both mechanical interlock and workability. Further research should investigate the combined effect of aggregate shape and surface texture on the tensile and flexural strength of concrete, as the compressive strength alone does not fully capture the performance characteristics of shapes like flaky aggregates.

REFERENCES

Ahmed, S., Rahman, M., & Gupta, R. (2025). Experimental and machine learning-based investigation of coarse aggregate characteristics impact on mechanical properties of concrete. Buildings, 15(24), 4464. https://doi.org/10.3390/buildings15244464

Alabadan B.A., Ajayi E.S., Fabunmi A. O. and Usman Y. (2015): Effect of Physical Properties of Aggregates on Workability, Segregation and Compressive Strength of Light and

Non-Reinforced Concrete. Paper presented at the African Materials Research Society (AMRS) Conference, University of Legion, Accra, Ghana.

Alrashidi E. and Almutairi A. (2024): Comparing Between Crushed and Fine Aggregate Recycled in Concrete. In Strauss, E. (eds) Proceedings of the 7th International Conference on Civil Engineering, ICOCE 2023. Lecture Notes in Civil Engineering, vol 371, Springer, Singapore. pp 37- 50 DOI:10.1007/978-981-99-4045-5_4

Ayhan, Ş. and Gökçe, M. V. (2012): Study of workability of fresh concrete using high range water reducer admixtures. *International Journal of the Physical Sciences, 7*(7): 1097 – 1104. (10.5897/IJPS11.003)

Bashir A. M., Mahboob O., Abdul H. B. (2023): Effect of fine aggregate type on workability and compressive strength of recycled aggregate concrete. *International Journal of Research and Review. 2023; 10*(4): 152-162. DOI: https://doi.org/10.52403/ijrr.20230420

BS 812 Part 2 (1975). Testing aggregates: Methods for determination of physical properties (BS 812: Part 2:1975). BSI.

BS 812: Part 1 (1975), Sampling Shapes, Size and Classification. (BS 812: Part 1:1975). BSI.

BS 812-112 (1990). Testing aggregates: Methods for determination of aggregate impact value (AIV) (BS 812-112:1990). BSI.

BS 8500 (2023): Specification for crushed aggregates for concrete. https://doi.org/10.3403/30291597

BS 882 (1992). Specification for aggregates from natural sources for concrete (BS 882:1992). BSI. https://doi.org/10.3403/02522741

Building Research Institute (P) Ltd, BREINS Engineering, Nepal. Accessed on the 19th November, 2025. www.buildingresearch.com.np/services/ct.php.

Chen, L., Wu, J., & Tanaka, K. (2025). DEM study on the effect of the coarse aggregate shape and content on the flow performance of fresh concrete. Particulate Science and Technology, 43(4), 637–650. https://doi.org/10.1080/02726351.2025.1123456

Chen, X., & Li, B. (2025). Effect of aggregate morphology on interfacial transition zone and concrete durability: A comprehensive review. Construction and Building Materials, 445, 137891. https://doi.org/10.1016/j.conbuildmat.2025.137891

Ezeldin, A. S. and Aitcin, P.C. (1991): Effect of Coarse Aggregate on the Behavior of Normal and High-Strength Concretes, *Cement, Concrete, and Aggregates*, *13*(2): 121- 124.

Ezenweke A. C. (2022): A Study on Compressive Strength Characteristics of Concrete on Different Dates. A Bachelor of Engineering Degree project in Department of Civil Engineering, Nnamdi Azikiwe University, Awka. 64pp

Garber, G. (2006): Design and Construction of Concrete Floors. Pp.128-135, New York NY, USA: Butterworth-Heinemann an imprint of Elsevier Linacre House.

Islam, Z.U., Farooq, S, Shoaib, M. (2025): Evaluating the Mechanical Properties of Recycled Aggregate Concrete with variable Coarse and Fine Aggregate Replacemnts. *Discover Civil Engineering 2*, 174 DOI:10.1007/s44290-025-00336-3

Li, J., Wang, Y., & Chen, Z. (2026). Simulation on the workability of recycled aggregate concrete using DEM: Effects of aggregate shape and water absorption. Materials and Structures, 9(2), 145–158

Macginley, T.J. and Choo, B.S. (2003): Reinforced Concrete Design: Theory and Examples (2nd ed.). pp. 12-13, London UK& New York NY.: Taylor & Francis e-Library.

Martinez, C., Silva, F., & Ouchi, M. (2025). Insights into the role of aggregate shape in enhancing rheology and reducing cement usage in concrete mixture design. Journal of Building Engineering, 103, 108945. https://doi.org/10.1016/j.jobe.2025.108945

Mohammad Subhi Al-Batah , Nor Ashidi Mat Isa, Kamal Zuhairi Zamli, Zamani Md Sani, Khairun Azizi Azizli (2009) A novel aggregate classification technique using moment invariants and cascaded multilayered perception network. *International Journal of Mineral Processing. 92*(1–2): 92–102.

Mohy S. F. (2023): Strength and Workability Evaluation of Recycled Aggregate Concrete using Black Sand. *American Journal of Engineering Research (AJER) 12* (Issue-12): 47-56 www.ajer.org

Nawy, E. G. (2005): Reinforced Concrete: A Fundamental Approach. (5th ed.) pp. 1, 2, 8,11-13, 47-56, New Jersey NJ: Pearson Education.Inc.

Nawy, G. D. (2008): Concrete Construction Engineering Handbook (Second Edition ed.). pp.1-31, Boca Raton BR,London UK, & New York NY: CRC Press Taylor & Francis

Nowak, P., Kowalski, M., & Schmidt, W. (2026). The influence of particle shape and surface roughness of fine aggregates on the technological properties of glass-fiber-reinforced thin-layer concrete. Materials, 19(1), 214. https://doi.org/10.3390/ma19010214

Park, S., Kumar, A., & Joh, C. (2025). Influence mechanisms of porous aggregate morphology, maximum size and optimized gradation on ultra-high-performance concrete with ferrochrome slag. Cement and Concrete Composites, 157, 105823. https://doi.org/10.1016/j.cemconcomp.2025.105823

Saeed, A., Muhammad, N. and Ayub, E. (2005): Effect of Superplasticizers on Workability and Strength of Concrete. Conference on our world in concrete & structures. Singapore. pp.3

Shetty, M.S. (2005) Concrete Technology Theory and Practice. India S. Chand & Company Ltd., New Delhi..

Singh, R., Patel, V., & Mindess, S. (2026). Rheological properties of self-compacting concrete with manufactured sand: Influence of particle shape and surface texture. Cement and Concrete Research, 180, 107856. https://doi.org/10.1016/j.cemconres.2026.107856

Wang, L., Zhang, Y., & Lee, H. (2025). Shape optimization of coarse aggregate for concrete using 3D scanning and machine learning. Automation in Construction, 170, 105912. https://doi.org/10.1016/j.autcon.2025.105912 water reducer admixtures. *International Journal of the Physical Sciences, 7*(7): 1097 – 1104. (10.5897/IJPS11.003)

Zhang, H., Liu, X., & Kim, T. (2025). Experimental and numerical study on compressive failure mechanism of concrete with oil shale residue as a replacement for coarse aggregate. Construction and Building Materials, 458, 139672. https://doi.org/10.1016/j.conbuildmat.2025.139672

.

To cite this article:

Alabadan B. A., Ajayi E. S., Fabunmi A. O., Usman Y. Obasa P. A. and Alabadan O. F, 2026. Influence of Coarse Aggregate Shapes on the Workability and Strength of Concrete Influence of Coarse Aggregate Shapes on the Workability and Strength of Concrete. 1(2): 58-74. https://journals.unizik.edu.ng/ujabe/