



RESEARCH ARTICLE

The Characteristics of Andesite and Sandstone as Aggregate Substitution in Concrete Mixtures

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Abstract

Aggregates make up the biggest part of concrete. The use of locally available aggregate in concrete production can reduce transportation distance and potentially minimize the carbon footprint. The objective of this study is to analyze local aggregates is andesite and sandstone that from a region in Riau. The method of research is an experiment in laboratory for identification of the chemical composition, abrasion resistance testing, and concrete compressive strength testing with these local aggregates. Concrete samples were made with a target strength of 30 MPa and tested after 7, 14, and 28 days of curing. The results showed that the higher chemical content of SiO₂ for andesite aggregate is a 44.66 % and for sandstone aggregate is 64.63%. The abrasion resistance for andesite aggregate is a 12.40% and sandstone aggregate is 66.00%, indicating that the andesite aggregate meets specification is a level below 40%. Meanwhile, the concrete compressive strengths of 32.35 MPa after 28 days of curing for andesite aggregate and 11.70 MPa for sandstone aggregate indicate that the andesite aggregate achieved the expected compressive strength of 30 MPa. Research indicates that while sandstone has a higher SiO₂ than andesite, it yields lower abrasion resistance and concrete compressive strength than andesite aggregate. This reinforce the fact that high SiO₂ content does not directly guarantee increased concrete compressive strength. Rather, abrasion values and mechanical characteristics of the aggregate must be considered collectively. Local andesite aggregate is suitable for structural concrete mixes, whereas sandstone aggregate is appropriate for non-structural applications.

Keywords: Characteristic, Andesite, Sandstone, Aggregate, Concrete

1. Introduction

Concrete is the most commonly used building material around the world because it can be used in many different ways, lasts a long time, and is not too expensive to make (Handayani et al., 2023). It is extensively applied in various infrastructure projects, including buildings, bridges, highways, airports, and hydraulic structures (Mundra et al., 2020). The quality and concrete efficiency are highly affected by the characteristics of its component materials, namely cement, water, aggregates, and admixtures. Amidst these components, aggregates take up around 60–75% of the overall concrete volume and are essential in influencing the mechanical characteristics, size stability, and longevity of concrete (Czinder & Torok, 2021). Therefore, choosing appropriate aggregate materials is crucial to guarantee the creation of high-grade concrete (Kurniawandy et al., 2025).

Natural aggregates used in concrete production are generally derived from igneous, sedimentary, and metamorphic rocks (Ren & Yin, 2022). Andesite, an igneous volcanic rock, is widely utilized as a coarse aggregate due to its high strength, low porosity, and excellent abrasion resistance (Bahrami et al., 2019). Its dense mineral composition contributes to superior mechanical performance, making it suitable for structural concrete and rigid pavement applications (Ariawan et al., 2024). In contrast, sandstone is a sedimentary rock mainly made up of mineral particles sized like sand, bonded by natural cementing materials (Abdurrokhim et al., 2022). The

engineering properties of sandstone differ considerably contingent upon its mineralogical creation, degree of weathering, and cementation characteristics (Abidin et al., 2024). As a result, its suitability as a concrete aggregate remains a subject of investigation, particularly in regions where sandstone deposits are abundant and economically attractive (Cheshomi et al., 2020).

The increasing demand for construction materials has encouraged the utilization of locally available aggregate resources to reduce transportation costs and support sustainable infrastructure development (Fauzi et al., 2020). In many areas, both andesite and sandstone are readily available and are frequently considered as alternative aggregate sources (Winarno et al., 2020). However, differences in their mechanical and physical characteristics may significantly impact concrete execution (Java et al., 2026). Parameters such as specific gravity, water absorption, abrasion resistance, particle shape, and surface texture influence the bond between aggregates and cement mortar, which ultimately determines the compressive and durability of concrete (Handayani et al., 2023).

Andesite and sandstone are two commonly used types of aggregates in concrete mixes. Andesite, a volcanic rock, is known for its hardness and high strength, making it a preferred choice in many construction applications (Davidovits et al., 2019). The appearance of Andesite Hill is shown in Figure 1.



Fig 1. Andesite Hill

On the other hand, sandstone, a sedimentary rock, is more readily available and generally more economical (Kumar et al., 2018). The appearance of Andesite Hill is shown in Figure 2.



Fig 2. Sandstone Hill

The research intends to assess the physical and mechanical characteristics of andesite and sandstone aggregates and to analyze their influence on the compressive strength of concrete (Ren & Yin, 2022). Laboratory tests were conducted to determine specific gravity, water absorption, bulk density, and Los Angeles abrasion values of both aggregate types. Concrete specimens were subsequently prepared and tested to assess their compressive strength development (Czinder & Török, 2021). The results of this study are expected to provide a scientific basis for aggregate selection in concrete construction and contribute to the efficient utilization of local natural resources in sustainable infrastructure development (Elsheikh et al., 2020).

The research gap addressed in this study lies in the limited experimental information regarding the suitability of locally sourced andesite at Pangkalan, West Sumatra, and sandstone at Kuok, Riau. The aggregate for producing concrete with a target compressive strength of 30 MPa.

1.1 Specific Gravity Test

Specific gravity refers to the weight ratio of aggregate to the weight of an equal volume of water at a designated temperature (Asadi et al., 2022). This parameter is used in concrete mix design calculations and provides an indication of aggregate density and quality (Renaldi & Botjing, 2023).

The obtained values were evaluated against the applicable aggregate specification, with specific gravity and water absorption considered as indicators of aggregate density and porosity characteristics. The specific gravity of aggregate is commonly classified. Reference value for normal aggregate specification for concrete, as shown in Table 1.

Table 1 . Parameter of Aggregate

Parameters of aggregates	Value
Bulk specific gravity	≥ 2.50
Saturated surface dry specific gravity	≥ 2.50
Apparent specific gravity	≥ 2.50
Water absorption	≤ 3.00

Aggregates with higher specific gravity typically possess greater density and strength, contributing to improved concrete performance.

1.2 Los Angeles Abrasion Test

The Los Angeles Abrasion Test is conducted to assess the durability of coarse aggregate against wear, impact, and abrasion (Umar et al., 2020). The test involves rotating aggregate particles together with steel balls in a machine in Los Angeles (LA) for a designated number of rotations (Palassi & Danesh, 2016). The aggregate was oven-dried and separated according to the specified grading, namely between 2,36 mm to 50 mm. A predetermined mass of aggregate was placed into the Los Angeles drum together with the required steel-ball abrasive charge. The drum was rotated for 500 revolutions at the specified rotational speed. After testing, the material was removed from the drum and sieved according to the standard. The remaining aggregates were weighed, and the percentage of mass loss was calculated as the Los Angeles Abrasion value. The ratio of abrasion loss is determined as:

$$LA \text{ Abrasion } (\%) = \frac{W_1 - W_2}{W_1} \quad (1)$$

where:

W_1 = initial aggregate weight (g)

W_2 = final aggregate weight after testing (g)

Lower abrasion values indicate higher aggregate toughness and durability (Kurniasih et al., 2026). For pavement and structural concrete applications, abrasion values below 40% are generally preferred.

1.3 Analysis of Chemical Composition in Aggregates

The chemical makeup of aggregates is a key factor in assessing their appropriateness for concrete manufacturing. Along with physical and mechanical traits, the mineralogical and chemical properties of aggregates affect the durability of concrete, strength development, and resistance to chemical attack (Fauzi et al., 2020). Certain chemical compounds may react adversely with cement hydration products, leading to the gradual decline of concrete structures over time.

Chemical composition analysis is an essential procedure in evaluating the suitability of aggregates for concrete production. In addition to physical and mechanical properties, the chemical constituents of aggregates significantly influence the performance, durability, and long-term stability of concrete structures (Usman et al., 2023). The presence of major oxides such as silicon dioxide (SiO_2), alumina (Al_2O_3), ferric oxide (Fe_2O_3), quicklime (CaO), magnesium oxide (MgO), sodium oxide (Na_2O), and potassium oxide (K_2O) can affect the interaction between aggregates and cementitious materials (Handayani et al., 2023). Furthermore, specific chemical substances can initiate harmful reactions, like the alkali-silica reaction (ASR), potentially resulting in the expansion, cracking, and degradation of concrete over time (Java et al., 2026). Consequently, the chemical characterization of aggregates is essential to evaluate their quality, recognize potentially harmful components, and guarantee adherence to technical specification of structural and pavement concrete.

uses. In this study, the chemical composition of andesite and sandstone aggregates was analyzed to determine their major elemental constituents and evaluate their potential suitability as aggregate materials in concrete mixtures.

1.4 Compressive Strength Test of Concrete

Compressive strength ranks among the most crucial mechanical properties of concrete and serves as the primary indicator of concrete quality and structural performance (Harmiyati et al., 2024). It represents the capacity of solidified concrete to withstand axial compressive loads without failure (López et al., 2023). The concrete's compressive strength is affected by various factors, such as the water-cement ratio, type of cement, properties of aggregates, curing conditions, size of specimen, and age at which testing is performed (Jahed Armaghani et al., 2016).

The compressive strength test is conducted by applying a continuously increasing compressive load to a standard concrete specimen until failure occurs (Naderi & Kaboudan, 2021). The test is usually conducted with cylindrical samples that are 150 mm in diameter and 300 mm in height (Basu et al., 2021). The compressive strength of concrete is determined using the following Equation 2.

$$f'c \text{ (MPa)} = \frac{P}{A} \quad (2)$$

where:

- $f'c$ = compressive strength of concrete (MPa)
- P = maximum load applied at failure (N)
- A = cross-sectional area of the specimen (mm²)

Concrete compressive strength is typically assessed at certain curing durations, usually 7, 14, and 28 days (Yang et al., 2020). The 28-day compressive strength is widely accepted as the standard reference value for quality control and structural design because concrete has developed the majority of its design strength by this age.

The compressive strength test is an essential procedure for evaluating the performance of concrete in mechanical terms and assessing the suitability of aggregate materials for structural and pavement applications (Melati, 2019). The test results provide a quantitative basis for comparing different aggregate sources and determining their influence on the overall quality of concrete mixtures (Amin et al., 2018).

2. Materials and Methods

The research utilizes an experimental laboratory approach to explore the characteristics of andesite and sandstone aggregates and their influence on the compressive capacity of concrete. The study was carried out through a sequence of organized phases, including material collection, aggregate characterization, concrete formulation, sample creation, hydration, and compressive strength assessment.

In this study, concrete mixtures were produced using locally available aggregate materials, namely andesite and sandstone. The aggregate sources are taken from the outskirts of the Riau region, where the andesite stone is in Pangkalan, West Sumatra, and Sandstone is in Kuok, Riau. The use of local aggregates is expected to reduce material transportation costs, promote sustainable resource utilization, and provide valuable information regarding their suitability for concrete applications. The physical appearance of both aggregates is shown in Figure 3.



Fig 3. Andesite (a) and Sandstone (b)

Figure 3 shows the visual characteristics of the andesite and sandstone aggregates used in this research. The andesite aggregate exhibits a dark gray to black color with a dense and compact texture, indicating its volcanic igneous origin. Andesite is generally characterized by high hardness, low porosity, and excellent resistance to abrasion, making it a suitable material for structural concrete and rigid pavement applications. The irregular shape and coarse surface texture of the andesite aggregate can also enhance the mechanical interlocking and bonding among the aggregate and cement paste, leading to increased concrete durability. In opposition, the sandstone aggregate displays a light brown to grayish color with a relatively granular texture. Sandstone, a type of sedimentary rock, mainly consists of mineral particles that are sand-sized, with quartz being the most abundant, bonded by natural cementing materials. Compared to andesite, sandstone generally possesses higher porosity and water absorption, which may affect the standard of the Interfacial Transition Zone (ITZ) between aggregate particles and cement paste. The engineering characteristics of sandstone differ based on its mineral content, degree of cementation, and weathering conditions. Research stages in the form of a flowchart as shown in Figure 4.

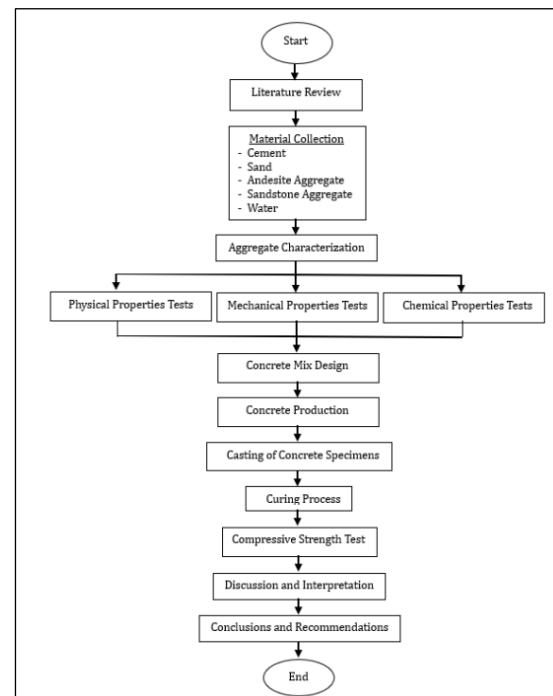


Fig 4. The Research Flowchart

Figure 4 illustrates the research methodology, which begins with a literature review and material collection. Followed by aggregate characterization through physical, mechanical, and chemical property tests. Based on the characterization results, a concrete mix design was

developed, followed by concrete production, specimen casting, and curing. The performance was evaluated through compressive strength testing.

The concrete mixture was designed for rigid pavement with a target compressive strength (F'c) of 30 MPa and a water-cement ratio (w/c) of 0.54 with cement OPC type I. The concrete samples were prepared for each type of aggregate, with curing periods of 7, 14 and 28 days. The material composition required for 1 m³ are presented in Table 1.

Table 1. Mix Proportions

Material	Andesite (kg)	Sandstone (kg)
Crushed Stone 2-3	421.7	424.1
Crushed Stone 1-2	590.4	593.8
Stone Dust	674.7	678.6
Cement	420	420
Water	226.8	226.8

Table 2. The Result of Physical Aggregate Test

Type of Testing	Andesite			Sandstone			Specification
	2 - 3	1 - 2	Stone Dush	2 - 3	1 - 2	Stone Dush	
Bulk specific gravity	2.588	2.580	2.559	2.550	2.574	2.511	
Saturated surface dry specific gravity	2.680	2.669	2.580	2.582	2.628	2.683	>2,1
Apparent specific gravity	2.634	2.625	2.569	2.566	2.601	2.597	
Water absorption (%)	1.324	1.282	0.321	1.242	0.793	2.567	<3%

Based on Table 1, all aggregates met the minimum specification requirement of greater than 2.1, indicating that the aggregates possess adequate density and are suitable for use in normal-weight concrete. Higher specific gravity values generally indicate denser and stronger aggregate particles, which contribute positively to the mechanical performance of concrete. The water absorption results showed that all values were below the maximum allowable limit of 3%, indicating compliance with the specification requirements for concrete aggregates.

To further evaluate the suitability of the aggregates for concrete applications, a chemical composition analysis was conducted using X-Ray Fluorescence (XRF). The evaluation was conducted to identify the major oxidative components present in the andesite and sandstone aggregates, which may influence their physical properties, durability, and interaction with cementitious materials. The findings of the chemical composition analysis is shown in Table 3

Table 3. Chemical Composition Aggregates

Chemical Compound	Andesite (%)	Sandstone (%)
SiO ₂	44.66	64.63
Fe ₂ O ₃	15.48	2.17
CaO	12.78	0.66
Al ₂ O ₃	11.18	16.27
MgO	7.64	5.63
K ₂ O	3.12	5.98
P ₂ O ₅	2.59	2.82
TiO ₂	1.77	1.34
Na ₂ O	0.61	0.51
MnO	0.20	0.00

Table 2 shows the findings of the X-Ray Fluorescence (XRF) analysis performed to identify the chemical makeup of the andesite and sandstone aggregates utilized in this research. The results indicate that both aggregates are predominantly composed of silicon dioxide (SiO₂), although

The differences in geological formation between andesite and sandstone are expected to influence their physical, mechanical, and chemical properties. Consequently, laboratory characterization tests were conducted to determine specific gravity, water absorption, abrasion resistance, and chemical composition of the aggregates. The results of these tests were subsequently correlated with the compressive strength performance of concrete produced using each aggregate type.

3. Result and Discussions

To evaluate the quality and suitability of the aggregates used in the concrete mixtures, a series of physical property tests was conducted on andesite and sandstone aggregates with three different aggregate sizes, namely 2–3 cm, 1–2 cm, and stone dust. The physical characterization involved measuring bulk specific gravity, saturated surface dry (SSD) specific gravity, apparent specific gravity, and water absorption. The test results are presented in Table 2.

the proportion varies significantly between the two rock types. The sandstone aggregate exhibited the highest SiO₂ content of 64.63%, whereas the andesite aggregate contained 44.66% SiO₂. The higher silica content in sandstone indicates that quartz is the dominant mineral constituent, which is consistent with the geological characteristics of sedimentary rocks. Quartz-rich aggregates generally possess good hardness and abrasion resistance; however, excessive reactive silica may increase the potential risk of alkali-silica reaction (ASR) in concrete.

The higher the SiO₂ content in aggregate > 40%, the higher the compressive strength of the concrete mixture obtained than that of a concrete mixture with aggregate of lower silica content (Janardan et al., 2024) (Kakasor Ismael Jaf et al., 2023).

However, the higher SiO₂ content of sandstone did not correspond to higher concrete compressive strength. This result, concrete containing andesite aggregate have compressive strength of 32.25 Mpa, whereas the sandstone aggregate concrete only 11.70 Mpa. Therefore, the result indicate that SiO₂ content alone cannot be used to explain to predict concrete compressive strength.

Following the examination of the aggregates' physical and chemical characteristics, their mechanical performance was subsequently evaluated using the Los Angeles Abrasion test. The wear value was calculated using the Los Angeles Abrasion equation presented in Equation (1). For andesite, W₁ (initial aggregate weight), total mass of aggregate before of 5000 g

$$LA \text{ Abrasion } (\%) = \frac{W_1 - W_2}{W_1} = \frac{5000 - 4380}{5000} = 12.4 \%$$

Aggregates with lower abrasion values generally exhibit higher durability and are more suitable for structural concrete applications. The results of the test can be found in Table 4.

Table 4. Abrasion Test Result

Aggregate Type	Initial Aggregate (gr) W1	Final Aggregate (gr) W2	Abrasion (%) LA	Specification Abrasion
Andesite	5000	4380	12,4	Max 40%
Sandstone	5000	1700	66	

Table 3 shows the abrasion values of the examined aggregates in Los Angeles. The abrasion test results indicate that the andesite aggregate exhibited an abrasion value of 12.4%, which is significantly lower than the maximum specification limit of 40%, demonstrating excellent resistance to wear, impact, and mechanical degradation. In contrast, the sandstone aggregate produced an abrasion value of 66%, exceeding the allowable limit and indicating poor durability and low resistance to fragmentation.

These findings suggest that andesite possesses superior mechanical properties and is more feasible for utilization in concrete production, particularly for construction applications demanding high strength and durability. The low abrasion value of andesite is expected to contribute positively to concrete compressive strength, durability, and performance in the future, whereas the high abrasion value of sandstone may lead to weaker aggregate particles, reduced concrete strength, increased susceptibility to cracking, and lower resistance to repeated loading and environmental deterioration.

3.1. Concrete Mix Design

Based on the aggregate characterization results, concrete mixtures were prepared using local andesite and sandstone aggregates to evaluate their suitability for structural concrete applications. The blending ratios were formulated to reach a desired compressive strength of 30 MPa while ensuring uniform cement and water levels. The impact of overall properties on concrete effectiveness will be evaluated. The mix design of concrete shows as Table 6.

Table 6. Mix Design of Concrete per 1 M³

Material	Aggregate Type	
	Andesite	Sandstone
Aggregate 2-3	421.7	424.1
Aggregate 1-2	590.4	593.8
Stone Dush	674.7	678.6
Cement (kg)	420.0	420.0
Water (liter)	226.8	226.8

Table 4 shows the concrete mix proportions used in this study for producing 1 m³ of concrete alongside a target compressive capacity of 30 MPa with a water-cement ratio (w/c) of 0.54. Based on the selected cement content of 420 kg/m², the required water content was calculated as $0.54 \times 420 = 226.8$ kg/m³, equivalent to approximately 226.8 liter/m³. Therefore, the cement and water content were kept constant for both aggregate types to maintain the same w/c ratio and target strength. The aggregate quantities were adjusted according to the respective aggregate characteristics, resulting in slightly different quantities of andesite and sandstone aggregates.

3.2. Concrete Compressive Strength

The compressive strength of concrete was evaluated through standard compression testing to assess the impact of aggregate characteristics on the strength development of concrete. The obtained results were analyzed and compared using the design compressive strength to evaluate the performance of concrete mixtures incorporating andesite and sandstone aggregates. The outcome of the compressive strength of concrete is shown in Table 5.

Table 5. Concrete Compressive Strength

Curing Age	Sample	Compressive Strength (MPa)	
		Andesite	Sandstone
7	1	16.98	7.92
	2	23.20	10.19
	3	17.54	10.47
	Average (MPa)	19.24	9.53
14	1	18.39	10.75
	2	28.29	10.19
	3	27.73	11.32
	Average (MPa)	24.81	10.75
28	1	29.14	10.75
	2	35.09	13.58
	3	32.82	10.75
	Average (MPa)	32.35	11.70

Table 5 presents the typical compressive strength results of concrete produced using andesite and sandstone aggregates at curing ages of 7, 14, and 28 days. The finding indicated a notable disparity in strength growth between the two types of aggregate. At 28 days, the andesite concrete achieved an average compressive strength of 32.35 MPa, exceeding the target design resilience of 30 MPa. Meanwhile, the sandstone concrete reached an average compressive strength of only 11.70 MPa, which is significantly lower than the design strength requirement. Overall, the results demonstrate that the use of andesite aggregate produced concrete that successfully achieved the target compressive strength of 30 MPa, whereas the sandstone aggregate failed to meet the design strength requirement. Therefore, andesite is regarded as an appropriate aggregate for structural concrete uses, while the sandstone aggregate investigated in this study is less suitable for producing concrete with a compressive strength goal of 30 MPa.

The average concrete compressive strength results obtained at curing ages of 7, 14, and 28 days are shown in Figure 5.

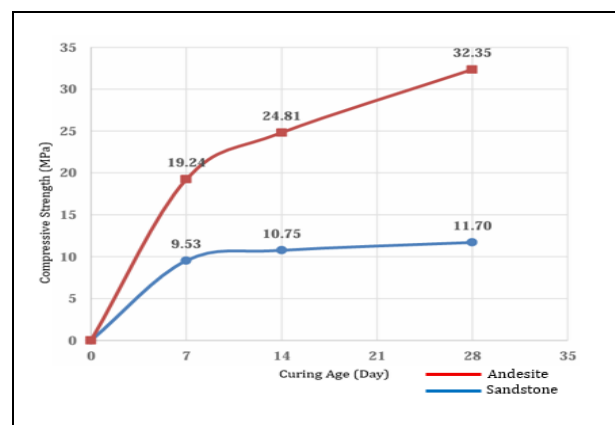


Fig 5. Concrete Compressive Strength

Figure 5 represents the compressive strength growth of concrete containing andesite and sandstone aggregates at curing ages of 7, 14, and 28 days as the age of concrete curing increases, the compressive strength of the concrete. Andesite exhibits higher compressive strength development compared to sandstone across all curing ages. At 28 days, the compressive strength of andesite reached 32.35 MPa, whereas sandstone reached only 11.70 MPa. This difference indicates that andesite possesses a greater capacity to withstand compressive loads than sandstone. These results align with the abrasion test findings, where andesite showed an abrasion value of 12.4%, while sandstone reached 66%. Given the maximum abrasion limit 40%, andesite remains within the required specifications. Chemical analysis revealed that sandstone has an SiO₂ content of 64.63%, which is higher than the andesite content of 44.60%. However, the high SiO₂ content in sandstone did not translate into increased concrete compressive strength; thus, it can be concluded that there is no direct correlation between total SiO₂ percentage and concrete compressive strength. This relationship would differ if the SiO₂ originated from a pozzolanic material, as reactive silica can contribute to the formation of C-S-H (Calcium Silicate Hydrate), further research is needed.

The variability and consistency of the 28-day compressive strength results were evaluated using the Standard Deviation (SD) and Coefficient of Variation (CV), calculated from the three specimens tested for each aggregate type as follows.

Andesite Aggregate

Average :

$$\bar{X} = \frac{X_1 + X_2 + X_3}{3}$$

$$\bar{X} = \frac{29.14 + 35.09 + 32.82}{3} = 32.35 \text{ MPa}$$

Standard Deviation (SD) for Andesite :

$$SD = \sqrt{\frac{\sum (X_i - \bar{X})^2}{n - 1}}$$

$$SD = \sqrt{\frac{18.03}{3 - 1}} = 3.00 \text{ MPa}$$

Coefficient of Variation (CV) for Andesite :

$$CV = \frac{SD}{\bar{X}} \times 100\%$$

$$CV = \frac{3.00}{32.35} \times 100\% = 9.27$$

The analysis results for sandstone are as shown in the Table 7.

Table 7 Standard Deviation (SD) and Coefficient of Variation (CV)

Sample	X _i	X _i - $\bar{X}$	(X _i - $\bar{X}$) ²	SD	CV
Andesite					
1	29.14	-3.21	10.30	3.00	9.27
2	35.09	2.74	7.51		
3	32.82	0.47	0.22		
			18.03		
Sandstone					
1	10.75	-0.94	0.88	1.63	13.93
2	13.58	1.89	3.57		
3	10.75	-0.94	0.88		
			5.33		

The 28-day andesite concrete exhibited a standard deviation of 3.00 MPa and a coefficient of variation of 9.27

%, while sandstone concrete had a standard deviation of 1.63 MPa and a coefficient of variation of 13.93 %. The relatively low CV indicates that the compressive strength results have good consistency among the tested specimens, while the standard deviation reflects a limited variation around the mean strength.

Based on the outcome of the physical, chemical, and mechanical strength of compressive tests, aggregate characteristics were found to exert a considerable impact on the effectiveness of concrete. Andesite aggregate demonstrated superior properties, including compliance with specific gravity and water absorption requirements, a low Los Angeles Abrasion value of 12.4%, and the capability to create concrete with a compressive strength of 32.35 MPa after 28 days, exceeding the target design strength of 30 MPa. These results indicate that andesite possesses adequate strength, endurance, and resilience to mechanical degradation, rendering it very appropriate for structural concrete and rigid pavement applications.

In contrast, sandstone aggregate exhibited a Los Angeles Abrasion value of 66%, which exceeded the maximum allowable limit of 40%. Consequently, the concrete produced with sandstone aggregate achieved a 28-day compressive strength of only 11.70 MPa, significantly lower than the target strength. The poor performance of sandstone concrete can be attributed to the weak, porous nature of the aggregate, which restricted the formation of a robust bond between the aggregate and cement paste and diminished the concrete's overall load-bearing capacity.

The strength development trend further confirmed that concrete containing andesite aggregate experienced continuous and substantial strength gain throughout the curing period, whereas concrete containing sandstone aggregate showed only marginal improvement. These findings emphasize that aggregate quality is a critical factor in assessing the mechanical behavior, longevity, and lifespan of concrete constructions.

4. Conclusion

This research examined the traits of local andesite and sandstone aggregates and their influence on the performance of concrete with a compressive strength goal of 30 MPa. From the results gathered, the following conclusions can be inferred:

1. The Los Angeles Abrasion test demonstrated that andesite aggregate possessed excellent resistance to wear and fragmentation, with an abrasion value of 12.4%, which was significantly lower than the maximum permitted limit of 40%. In contrast, sandstone aggregate exhibited an abrasion value of 66%, exceeding the specification limit and indicating poor mechanical durability.
2. The findings from the 28-day compressive strength test show a notable disparity in the performance of concrete made with andesite and sandstone aggregates. Concrete incorporating andesite aggregate achieved an average compressive strength of 32.35 MPa, exceeding the target design strength of 30 MPa. This result demonstrates that the andesite aggregate possesses adequate physical and mechanical properties to produce high-quality structural concrete. In contrast, concrete containing sandstone aggregate achieved an average compressive strength of only 11.70 MPa, which is substantially lower than the design strength requirement.

The recommendation concerning the use of sandstone applies specifically to the sandstone aggregate investigated in this study and to the tested concrete mixture designed for a target compressive strength of 30 MPa. Further research is needed regarding different aggregate sources

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