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COMPARISON OF MOUNTAIN STONE AND RIVER STONE WITH THE SAME MIX ON THE COMPRESSIVE STRENGTH OF CONCRETE

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Informasi	**Abstract**

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The utilization of locally available aggregates is an important consideration in concrete production, particularly in regions where the availability and transportation of conventional river aggregates may affect construction efficiency. This study aims to evaluate the compressive strength performance of concrete incorporating Kepahiang mountain stone as an alternative coarse aggregate in comparison with Sungai Lais river stone. The experimental investigation was conducted using concrete mixtures with identical proportions and a water-to-cement ratio of 0.45, designed to achieve a target strength of K-300. A total of 12 cylindrical specimens were prepared, consisting of six specimens for each type of coarse aggregate, and compressive strength was evaluated after 14 days of curing. The physical and mechanical properties of the aggregates were also examined, including specific gravity, water absorption, and abrasion resistance. The results indicate that the concrete containing Sungai Lais river stone achieved a higher average compressive strength of 325.030 kg/cm², compared with 310.738 kg/cm² for the concrete containing Kepahiang mountain stone. The characteristic compressive strengths were 311.621 kg/cm² and 300.789 kg/cm², respectively, resulting in a difference of 10.832 kg/cm² or approximately 3.48%. Despite this difference, both mixtures achieved the targeted K-300 concrete strength. Furthermore, the average mass of the mountain-stone concrete specimens was 12.11 kg, lower than the 12.75 kg recorded for the river-stone concrete. These findings indicate that Kepahiang mountain stone has potential as a locally sourced alternative coarse aggregate for concrete production, particularly under mixture conditions comparable to those investigated in this study. Further research involving different curing ages, water-to-cement ratios, aggregate gradations, and durability parameters is recommended to establish its broader applicability in construction.

Keywords : *Concrete, Mountain Stone, River Stone, Coarse Aggregate, Compressive Strength, Local Material*

A. INTRODUCTION

Concrete is one of the most widely used construction materials due to its ability to withstand compressive loads, its versatility in shaping, and the relatively abundant availability of its constituent materials. Its performance is influenced by several mixture parameters, particularly the characteristics of coarse aggregates and the water–cement ratio (w/c ratio). Variations in the physical and mechanical properties of aggregates may lead to differences in concrete compressive strength, even when the mixture proportions are maintained under identical conditions. Therefore, selecting appropriate aggregate materials is essential to achieving concrete quality that meets specific construction requirements.

The availability and characteristics of aggregate materials vary across regions. Kepahiang Regency, Bengkulu Province, possesses considerable potential for mountain stone resources, whereas river stone, which has traditionally been used as a construction material, is relatively limited in availability and must be transported from the Sungai Lais/Lubuk Gedang Quarry area in Mukomuko Regency. This condition creates an opportunity to optimize locally available mountain stone as an alternative aggregate source. Nevertheless, its application in concrete requires technical evaluation to determine whether its material characteristics are capable of producing adequate compressive strength.

The differences in the characteristics of mountain stone and river stone provide a basis for comparative testing. This study compares concrete incorporating the two aggregate types while maintaining the water–cement ratio at 0.45. Controlling the mixture conditions enables a more precise assessment of the contribution of aggregate type to concrete compressive strength. The study uses Type I Portland cement and cylindrical specimens measuring 15 × 30 cm. A total of 12 specimens were prepared, comprising six specimens containing mountain stone aggregate from Kepahiang and six specimens containing river stone aggregate from Sungai Lais/Lubuk Gedang Quarry. Compressive strength testing was conducted at 14 days of curing.

The primary research problem concerns the extent to which the use of different aggregate sources affects concrete compressive strength when the water–cement ratio and other mixture parameters are kept constant. In addition to comparing compressive strength values, the study examines the magnitude of the performance difference between the two concrete types and evaluates the potential of mountain stone from Kepahiang as an alternative to river stone. This focus is consistent with the research objective of identifying differences in compressive strength and assessing the feasibility of mountain stone as an alternative aggregate for construction applications.

The results indicate that concrete incorporating mountain stone aggregate from Kepahiang achieved a compressive strength of 300.789 kg/cm², whereas concrete containing river stone aggregate from Sungai Lais achieved 311.621 kg/cm², resulting in a difference of 10.832 kg/cm². Although the mountain stone concrete exhibited a slightly lower compressive strength, its performance remained relatively close to that of the river stone concrete. These findings provide empirical evidence that mountain stone from Kepahiang has potential as a locally available alternative aggregate, thereby supporting the more efficient utilization of regional material resources for construction purposes.

Concrete

Concrete is a composite construction material produced by combining cement, water, fine aggregate, and coarse aggregate. In this mixture, cement and water form a binding paste, while the aggregates function as fillers and constitute a major portion of the concrete matrix, thereby influencing its mechanical properties. As cement hydration progresses, the mixture gradually transforms from a plastic state into a hardened material with increasing stiffness and strength. According to Tjokrodimuljo (1993), the strength development of concrete is closely associated with its age and the hydration reaction between cement and water. The formation of hydration products, particularly calcium silicate hydrate (C-S-H), plays a fundamental role in establishing cohesive bonds among the constituent materials.

The performance of concrete is determined not only by the cement–water composition but also by the physical and mechanical characteristics of the aggregates. Aggregate size, grading, shape, surface texture, specific gravity, water absorption, and strength can affect the density and load-bearing capacity of the resulting concrete. Consequently, the selection of coarse aggregate represents an important consideration when comparing concrete quality derived from different material sources. In this study, particular attention is given to the differences in the characteristics of mountain stone obtained from Kepahiang and river stone sourced from the Lais River/Lubuk Gedang Quarry, while maintaining the same water-to-cement ratio. This comparison provides a basis for evaluating how variations in coarse aggregate characteristics may influence concrete performance under equivalent mix conditions.

Workability

Workability refers to the ability of fresh concrete to be mixed, transported, placed, and compacted efficiently without causing significant difficulties or altering the composition and uniformity of the mixture. Tjokrodimuljo (1993) states that water content and aggregate size characteristics are among the factors that influence concrete workability. Smaller aggregate particles have a greater total surface area, which may consequently increase the amount of water required to achieve a given level of consistency.

According to Mindess et al. (1996), an adequately workable concrete mixture should exhibit several essential characteristics, including plasticity, cohesiveness, flowability, and mobility. Plasticity enables the mixture to undergo deformation during handling and placement, while cohesiveness helps maintain the integrity of its constituent materials and minimizes the risk of segregation. Flowability facilitates the placement of concrete, whereas mobility refers to the ability of the mixture to move and spread while maintaining its homogeneity.

Workability may also change during the period between mixing and concrete placement. Illston and Domone (2001) associate the reduction in workability with several processes, including water absorption by aggregates, evaporation of mixing water, the initiation of cement hydration, and interactions between admixtures and cement particles. Accordingly, variations in aggregate characteristics may produce different workability responses, even when the fundamental proportions of the concrete mixture remain identical.

Concrete Constituent Materials

Cement, coarse aggregate, fine aggregate, and water constitute the principal materials in concrete, with their respective properties and interactions collectively influencing the performance and quality of the resulting concrete. Portland cement Type I serves as the primary binding material, reacting chemically with water through hydration to form a cement paste that bonds the aggregate particles into a cohesive matrix. Coarse aggregate, consisting in this study of nominal 2/3-sized crushed stone obtained from mountain rock in Kepahiang and river stone sourced from Sungai Lais/Lubuk Gedang Quarry, occupies a substantial proportion of the concrete volume and contributes to its strength, density, shrinkage characteristics, and workability. Appropriate aggregate grading enables particles of different sizes to interlock and fill the available voids more effectively, thereby reducing internal void volume and improving the efficiency of cement paste utilization (Tjokrodimuljo, 2007; Antono, 1995; Zuraidah et al., 2017).

Fine aggregate complements the coarse aggregate by filling the smaller voids between larger particles, thereby promoting a denser and more homogeneous concrete structure. Its suitability is determined by several characteristics, including particle size and gradation, hardness, silt content, and the presence of organic impurities, all of which may affect concrete density, uniformity, and workability. Water, in turn, is essential for initiating cement hydration and maintaining the consistency required for mixing, placement, and compaction. Its quality and proportion must therefore be carefully controlled because excessive water can increase concrete porosity and consequently reduce strength, whereas insufficient water may interfere with proper mixing and compaction. Accordingly, achieving the desired concrete performance requires careful control of both the proportions and characteristics of each constituent material so that adequate density, workability, and strength can be obtained (Tjokrodimuljo, 1996).

Water–Cement Ratio

The water-cement ratio (FAS) is the ratio between the weight of water and the weight of cement in a concrete mix. Mathematically, FAS can be expressed as:

$$\text{FAS} = \frac{W\ water}{W cemen}$$

This parameter is fundamental to concrete mix design because it influences hydration, workability, compactness, and the development of compressive strength. Under controlled mixing conditions, an increase in the w/c ratio generally leads to lower compressive strength because excess water may leave additional capillary pores within the hardened concrete. Conversely, reducing the w/c ratio can enhance strength by producing a denser cementitious matrix; however, an excessively low ratio may reduce workability and hinder adequate compaction.

Accordingly, maintaining a consistent w/c ratio is particularly important when evaluating concrete mixtures incorporating different types of aggregates. Applying the same ratio to all mixtures helps ensure that variations in compressive strength are primarily associated with differences in aggregate characteristics rather than discrepancies in the proportions of water and cement. In this study, the w/c ratio was maintained at 0.45 for both mixtures, thereby providing a consistent basis for assessing the effect of the two aggregate types under comparable mixture conditions.

Gradation and Aggregate Characteristics

Aggregate gradation refers to the distribution of particle sizes within an aggregate mixture, typically determined through sieve analysis. This distribution influences particle arrangement and the extent to which aggregate particles interlock and fill the available voids. An appropriate gradation can minimize void content, improve packing density, reduce the volume of cement paste required, and contribute to the workability of fresh concrete. Consequently, aggregate gradation represents an important factor in achieving the desired physical and mechanical properties of concrete.

The importance of aggregate gradation is supported by Mulyati et al. (2016), who reported that the use of uniformly graded coarse aggregate reduced concrete compressive strength by 12.35% compared with continuously graded aggregate. The study further demonstrated that reducing the water-to-cement ratio (w/c ratio) from 0.50 to 0.45 increased compressive strength by 20.15%. These findings indicate that aggregate characteristics and the w/c ratio are not independent factors; rather, their interaction contributes to the overall performance of concrete. This relationship highlights the importance of optimizing both aggregate gradation and mixture proportions when designing concrete with targeted strength characteristics.

Consistent with this perspective, Setiyawan et al. (2017) found that differences in the type and size of coarse aggregate could produce substantial variations in the mechanical properties of concrete. Their findings showed that a specific combination of manually crushed and machine-crushed aggregates produced higher compressive strength, modulus of rupture, and modulus of elasticity than several other aggregate combinations. Thus, aggregate performance is influenced not only by particle-size distribution but also by aggregate type, production method, and particle characteristics, all of which should be considered collectively in concrete mixture design.

Compressive Strength of Concrete

Compressive strength is a fundamental parameter for assessing the capacity of concrete to withstand compressive loading. It is determined by dividing the maximum load sustained by a test specimen by the cross-sectional area subjected to the load. The resulting strength is governed by several interrelated factors, including cement quality, aggregate properties, water-to-cement ratio (W/C ratio), mixture compactness, curing conditions, and concrete age. Accordingly, compressive strength testing provides an essential basis for assessing and comparing the performance of concrete produced with different constituent materials.

Previous studies have demonstrated that variations in aggregate characteristics can influence the mechanical performance of concrete. Setiyawan et al. (2017) reported that differences in the type and size of coarse aggregates affected the mechanical properties of concrete, while Zuraidah et al. (2017) found that an appropriate combination of aggregate sizes could improve compressive strength. These findings indicate that aggregate characteristics play an important role in determining concrete performance. Therefore, comparing concrete containing mountain stone from Kepahiang with concrete incorporating river stone from Sungai Lais/Quarry Lubuk Gedang under the same W/C ratio provides a relevant basis for evaluating the relative performance of the two aggregate sources.

Mountain Stone and River Stone as Coarse Aggregates

Mountain stone and river stone originate from different geological and environmental processes, resulting in variations in their physical and mechanical characteristics. In the present study, the mountain stone was obtained from Kepahiang, whereas the river stone was sourced from Sungai Lais/Quarry Lubuk Gedang. Such differences may be reflected in several aggregate properties, including specific gravity, water absorption, particle shape, surface texture, and resistance to loading and abrasion. These characteristics can subsequently affect the bonding between aggregate particles and cement paste and, consequently, the mechanical performance of the resulting concrete.

The comparison between these two aggregate types is particularly relevant because this study seeks to assess whether locally available mountain stone from Kepahiang can serve as an alternative coarse aggregate to river stone. By maintaining the W/C ratio and mixture composition under comparable conditions, variations in compressive strength can be more directly associated with differences in aggregate characteristics. The findings presented in the thesis indicate that concrete incorporating mountain stone and river stone produces different compressive strength values. Thus, examining the characteristics and performance of these two aggregate sources is not only relevant from a scientific perspective but also provides practical considerations for selecting suitable coarse aggregate materials for concrete production.

B. RESEARCH METHODOLOGY

This study employed a quantitative experimental approach to evaluate and compare the compressive strength of concrete incorporating two different types of coarse aggregate: mountain stone obtained from Kepahiang and river stone sourced from the Lais River/Quarry Lubuk Gedang. The experimental program was conducted at the Laboratory of Universitas Prof. Dr. Hazairin, S.H., Bengkulu, and comprised several sequential stages, including material preparation, aggregate characterization, concrete mix design, specimen fabrication, curing, and compressive-strength testing. To ensure a valid comparison between the two aggregate types, the principal experimental variable was the type of coarse aggregate, while the water–cement ratio (w/c), cement type, specimen dimensions, compaction procedure, and testing age were kept constant. The concrete mixture was designed to achieve a target compressive strength of 30 MPa (fc′) using a water–cement ratio of 0.45, Portland Type I cement, and cylindrical specimens measuring 150 × 300 mm. The concrete mix proportioning followed SNI 7656:2012, while the compressive-strength testing procedure was conducted in accordance with the applicable standard specified in the original research.

The materials consisted of cement, water, fine aggregate, and two types of coarse aggregate, namely mountain stone and river stone. The mountain stone was obtained from the Kepahiang area and processed by crushing to produce coarse aggregate of the required size, whereas the river stone was collected from the Lais River/Quarry Lubuk Gedang. Prior to concrete production, the aggregates underwent a series of physical characterization tests to establish their suitability for use in the concrete mixture. The coarse aggregates were evaluated in terms of particle-size distribution, specific gravity, and abrasion resistance, while the fine aggregate was characterized based on gradation, bulk density, silt content, moisture content, and specific gravity. These preliminary examinations served as an essential quality-control stage before the mix-design process. In accordance with the procedures reported in the thesis, fine-aggregate gradation was examined with reference to SNI 03-1968-1990, whereas coarse-aggregate abrasion resistance was assessed according to SNI 2417:2008.

Concrete specimens were prepared using the mix proportions obtained from the normal-concrete mix design for a target strength of 30 MPa and a water–cement ratio of 0.45. Each constituent was weighed according to the predetermined mixture proportions and subsequently blended in a concrete mixer until a uniform mixture was obtained. The workability of the fresh concrete was then assessed using the Abrams slump cone before the mixture was placed into cylindrical molds. The concrete was compacted using a vibrator and left in the molds for approximately 24 hours before demolding. Following demolding, all specimens underwent water curing for 14 days under identical conditions. This procedure was applied consistently to both experimental groups to minimize variations attributable to specimen preparation and curing. The experimental design comprised two treatment groups: concrete containing Kepahiang mountain stone and concrete containing river stone from the Lais River/Quarry Lubuk Gedang. Each group consisted of six cylindrical specimens, resulting in a total of 12 specimens.

Table 1. Experimental Design and Number of Concrete Specimens

Code	Coarse Aggregate Type	Number of Specimens	Specimen Dimensions	w/c Ratio	Testing Age
MS	Kepahiang mountain stone	6 cylinders	150 × 300 mm	0.45	14 days
RS	Lais River/Quarry Lubuk Gedang river stone	6 cylinders	150 × 300 mm	0.45	14 days
Total	**Two aggregate types**	**12 cylinders**	**150 × 300 mm**	**0.45**	**14 days**

Compressive-strength testing was conducted after the specimens had reached the specified curing age of 14 days using a compression testing machine in accordance with SNI 03-2491-2002. The maximum load sustained by each cylindrical specimen was recorded as the primary experimental data, and the corresponding compressive strength was determined from the ratio between the maximum applied load and the specimen's cross-sectional area. The resulting data were first analyzed descriptively using individual measurements, mean values, tables, and graphical representations to identify the general strength characteristics of each experimental group. Subsequently, inferential analysis was performed using one-way analysis of variance (ANOVA) to determine whether the observed differences between the two aggregate groups were statistically meaningful; a Tukey post-hoc test was considered where further comparison was required. The comparative analysis ultimately focused on the difference in compressive strength between concrete incorporating mountain stone and that incorporating river stone under the same water–cement ratio, thereby providing a controlled assessment of the influence of coarse-aggregate type on concrete compressive performance.

C. RESULT AND DISCUSSION

Characteristics of Concrete Constituent Materials

This study evaluates the performance of concrete incorporating two types of coarse aggregates: mountain stone obtained from Kepahiang and river stone sourced from the Sungai Lais/Quarry Lubuk Gedang area. Both aggregates were incorporated into concrete mixtures with an identical water-to-cement ratio (W/C) of 0.45. Prior to concrete production, the physical and mechanical characteristics of the constituent materials were examined to establish their suitability for use in normal-weight concrete. The material characterization included particle-size distribution, specific gravity, water absorption, fine-material content, moisture content, and abrasion resistance. A total of 12 cylindrical specimens were prepared, comprising six specimens containing mountain stone and six containing river stone. This experimental arrangement provided a consistent basis for evaluating the influence of coarse aggregate type on concrete performance.

Characteristics of Fine Aggregate

Sieve analysis of the sand obtained from Quarry Seblat yielded a fineness modulus of 2.87, with the particle-size distribution falling within Zone II according to the classification of fine aggregates. This result indicates that the sand has a medium gradation, which is generally favorable for producing a balanced concrete mixture in terms of cement paste requirements, workability, and particle packing. The test was conducted in accordance with SNI 03-1968-1990, as specified in the original research.

Table 2. Characteristics of the Fine Aggregate

Parameter	Test Result	Unit
Fineness modulus	2.87	–
Bulk specific gravity	2.54	g/cm^3
SSD specific gravity	2.62	g/cm^3
Apparent specific gravity	2.77	g/cm^3
Water absorption	2.21	%
Material passing No. 200 sieve	0.99	%

Source: Research results, 2026, Laboratory of Universitas Prof. Dr. Hazairin, SH.

The proportion of fine material passing the No. 200 sieve was 0.99%. This relatively low value indicates that the amount of fine material potentially interfering with the bond between cement paste and aggregate was limited. Accordingly, the fine aggregate exhibited characteristics that were considered suitable for concrete production. Controlling the amount of fine material is important because excessive fines adhering to aggregate surfaces may increase water demand and subsequently influence the quality of the interfacial zone between the aggregate and cement paste.

Characteristics of Coarse Aggregates

The specific-gravity tests revealed distinct physical characteristics between the Kepahiang mountain stone and Sungai Lais river stone. The mountain stone exhibited a bulk specific gravity of 2.49, an SSD specific gravity of 2.52, an apparent specific gravity of 2.62, and water absorption of 1.25%. In comparison, the river stone showed higher values, with a bulk specific gravity of 2.74, an SSD specific gravity of 2.78, an apparent specific gravity of 2.86, and water absorption of 1.51%.

Table 3. Comparison of Coarse Aggregate Characteristics

Parameter	Kepahiang Mountain Stone	Sungai Lais River Stone
Bulk specific gravity	2.49	2.74
SSD specific gravity	2.52	2.78
Apparent specific gravity	2.62	2.86
Water absorption	1.25%	1.51%

Source: Research results, 2026.

The higher specific gravity of the river stone indicates that it possesses a greater mass per unit volume than the mountain stone. This difference was also reflected in the mass of the concrete specimens after curing. The concrete incorporating mountain stone had an average mass of 12.11 kg, whereas the specimens containing river stone had an average mass of 12.75 kg. Therefore, under identical mixture proportions, the use of mountain stone resulted in lighter concrete specimens.

The abrasion test further demonstrated differences in the mechanical characteristics of the two aggregates. The abrasion value was 24.60% for the Kepahiang mountain stone and 19.84% for the Sungai Lais river stone. Both values were reported in the thesis as satisfying the specified requirement of less than 26%. Nevertheless, the lower abrasion value of the river stone indicates comparatively better resistance to wear, while the mountain stone remained within the range considered acceptable for use as coarse aggregate in concrete.

These findings reinforce the view that concrete performance is governed not only by the cement paste but also by the quality and characteristics of the aggregate, which constitutes a major portion of concrete volume. Aggregates possessing appropriate gradation and mechanical properties can promote denser particle packing and consequently contribute to the development of concrete strength (Antoni & Nugraha, 2007).

Concrete Mix Design

The concrete mixtures were designed to achieve a target compressive strength of 30 MPa (K-300). A W/C ratio of 0.45 was adopted, with a target slump of 75–100 mm. Importantly, the mixture proportions for the two types of coarse aggregate were maintained at the same level. This approach was adopted to facilitate a more direct assessment of the effect of coarse aggregate type on compressive strength. The mixture design followed SNI 7656:2012.

Table 4. Concrete Mix Proportions for Six Cylindrical Specimens

Material	Proportion per m^3 (kg)	Proportion for 6 Cylinders (kg)
Coarse aggregate 2/3	1,100	38.48
Sand	646	22.60
Cement	483	16.88
Water	181	6.33
Total	2,410	–
W/C ratio	0.45	0.45
Target slump	75–100 mm	75–100 mm

Source: Research results, 2026.

Maintaining identical mixture proportions was essential to the experimental design because it allowed the type of coarse aggregate to serve as the principal comparative factor. Similarly, the use of the same W/C ratio ensured that the two concrete mixtures were produced under comparable cement-paste and mixing-water conditions. This consideration is consistent with Tjokrodimuljo (1993), who identified the water–cement ratio as one of the principal factors governing concrete compressive strength.

In this context, controlling the W/C ratio was particularly important because changes in water content can simultaneously affect workability and concrete porosity. A higher W/C ratio generally produces a more fluid cement paste and may increase the volume of voids after hardening, whereas an excessively low W/C ratio may reduce workability and hinder adequate compaction. Therefore, maintaining the W/C ratio at 0.45 helped establish comparable experimental conditions for the two aggregate types.

Workability and Curing of Concrete Specimens

The concrete mixtures were prepared using the previously characterized materials. After mixing in a concrete mixer, the fresh concrete was subjected to a slump test before being placed into cylindrical molds. Six specimens were prepared for each aggregate type. Following casting and compaction, the specimens were left for approximately 24 hours before being removed from the molds and subjected to water curing for 14 days.

Applying the same production and curing procedures to both groups was intended to minimize the influence of external variables on the measured concrete properties. This consistency is particularly important because differences in compaction, curing conditions, or fresh-concrete characteristics may introduce variations in compressive strength. Accordingly, maintaining uniform procedures provides a stronger basis for relating the observed differences in compressive strength to the characteristics of the coarse aggregates.

Mass of Concrete Specimens after Curing

The mass of the concrete specimens was determined by comparing their weights before and after immersion. Following 14 days of curing, the concrete containing mountain stone exhibited an average mass of 12.11 kg, whereas the concrete containing river stone reached 12.75 kg.

Table 5. Mass of Concrete Specimens after 14 Days of Curing

No.	Mountain Stone (kg)	River Stone (kg)	Difference (kg)
1	12.120	12.740	0.62
2	12.080	12.670	0.59
3	12.000	12.770	0.77
4	12.220	12.780	0.56
5	12.160	12.760	0.60
6	12.090	12.780	0.69
Total	**72.67**	**76.50**	**3.83**
Average	**12.11**	**12.75**	**0.64**

Source: Research results, Faculty of Engineering Laboratory, Universitas Prof. Dr. Hazairin, SH.

The results indicate that the average mass of the mountain-stone concrete was approximately 0.64 kg lower per specimen than that of the river-stone concrete. This difference is consistent with the specific-gravity results presented previously, in which the river stone exhibited a higher specific gravity than the mountain stone. Consequently, under the same mixture proportions, the use of mountain stone resulted in a lower specimen mass.

Nevertheless, the lower mass should not be interpreted directly as evidence that the concrete qualifies as lightweight concrete. Rather, the result demonstrates a difference in specimen mass associated with the physical characteristics of the coarse aggregates. The classification of concrete as lightweight or normal-weight concrete should be based on the unit weight of the concrete as a whole and the applicable classification criteria.

Water Absorption of Concrete

Changes in specimen mass before and after immersion were also used to assess the water absorption characteristics of the concrete. According to the calculations reported in the thesis, the water absorption of the mountain-stone concrete was 0.00034%, whereas that of the river-stone concrete was 0.0006%.

These results indicate, based on the calculations presented in the original thesis, that the river-stone concrete exhibited higher water absorption than the mountain-stone concrete. However, this finding should be interpreted cautiously because an apparent inconsistency exists between the specimen-mass data and the reported absorption percentages. Therefore, before publication in a scientific journal, the absorption values should be rechecked against the original laboratory measurements and calculation procedures. This verification is necessary to ensure consistency between the reported data and the interpretation of the concrete's absorption characteristics.

Compressive Strength of Concrete at 14 Days

Compressive strength was the principal performance parameter used to compare the two concrete mixtures because both aggregate types were incorporated under the same mixture proportions and W/C ratio. Six specimens from each group were tested at the age of **14 days**. The results demonstrate that both mixtures developed relatively high compressive strength and approached or exceeded the target K-300 strength.

Table 6. Compressive Strength of Concrete at 14 Days

No.	Kepahiang Mountain Stone (kg/cm²)	Sungai Lais River Stone (kg/cm²)
1	305.578	331.043
2	309.822	335.287
3	322.555	325.286
4	309.822	322.555
5	307.832	312.554
6	308.821	323.456
Total	**1,864.431**	**1,950.181**
Average	**310.738**	**325.030**

Source: Research results, Faculty of Engineering Laboratory, Universitas Prof. Dr. Hazairin, SH.

As shown in Table 6, the average compressive strength of the mountain-stone concrete was 310.738 kg/cm², whereas the river-stone concrete achieved an average of 325.030 kg/cm². Thus, the river-stone concrete exhibited an average compressive strength approximately 14.292 kg/cm² higher than that of the mountain-stone concrete.

At the individual-specimen level, the highest compressive strength recorded for the mountain-stone concrete was 322.555 kg/cm², compared with 335.287 kg/cm² for the river-stone concrete. The corresponding minimum values were 305.578 kg/cm² and 312.554 kg/cm², respectively. Although the river-stone concrete consistently produced somewhat higher values, the ranges observed for the two groups remained relatively close. This suggests that both aggregate types were capable of producing concrete with comparable compressive-strength performance under the experimental conditions.

Characteristic Compressive Strength

Further analysis was conducted using the mean compressive strength and standard deviation to determine the characteristic compressive strength. Based on the calculations reported in the thesis, the river-stone concrete produced a standard deviation of 8.176 kg/cm² and a characteristic compressive strength of 311.621 kg/cm². This result was reported as corresponding to the K-300 concrete grade.

For the mountain-stone concrete, the calculated standard deviation was 6.067 kg/cm², resulting in a characteristic compressive strength of 300.789 kg/cm². This value was likewise reported to satisfy the target K-300 grade.

Table 7. Comparison of Characteristic Compressive Strength

Parameter	Kepahiang Mountain Stone	Sungai Lais River Stone
Average compressive strength (kg/cm²)	310.739	325.030
Standard deviation (kg/cm²)	6.067	8.176
Characteristic compressive strength (kg/cm²)	300.789	311.621
Target grade	K-300	K-300

Source: Research results, 2026.

The results demonstrate that both concrete mixtures achieved the characteristic strength targeted in the study. Although the river-stone concrete produced a higher characteristic strength, the difference between the two mixtures remained relatively limited in relation to the specified concrete grade. This finding suggests that Kepahiang mountain stone has potential for use as an alternative coarse aggregate when the same mixture conditions are applied.

Comparison of Concrete Compressive Strength

A direct comparison of the characteristic compressive strengths is presented in Table 8.

Table 8. Difference in Characteristic Compressive Strength

Concrete Type	Characteristic Compressive Strength (kg/cm²)	Difference (kg/cm²)
Kepahiang Mountain Stone	300.789	10.832
Sungai Lais River Stone	311.621	–

Source: Research results, 2026.

The difference in characteristic compressive strength between the two concrete mixtures was 10.832 kg/cm². Relative to the characteristic strength of the river-stone concrete, this difference corresponds to approximately 3.48%. Accordingly, the characteristic compressive strength of the mountain-stone concrete was approximately 96.5% of that obtained using river stone.

This relatively small difference is an important finding because it demonstrates that replacing the river stone with Kepahiang mountain stone did not result in a substantial reduction in the target concrete performance. Although the river stone produced higher compressive strength, the mountain-stone concrete still achieved the specified K-300 target under the experimental conditions. Therefore, differences in aggregate characteristics did not prevent the mountain-stone mixture from attaining the required strength level.

D. CONCLUSION

Based on the experimental results, the use of coarse aggregates with different physical characteristics under identical concrete mixture proportions resulted in a measurable difference in compressive strength. The concrete incorporating Kepahiang mountain stone achieved a characteristic compressive strength of 300.789 kg/cm², whereas the concrete containing Sungai Lais river stone reached 311.621 kg/cm². Thus, the characteristic compressive strength of the mountain-stone concrete was 10.832 kg/cm² lower than that of the river-stone concrete. Despite this difference, the mountain-stone concrete remained relatively close in performance to the river-stone concrete and achieved the target K-300 strength specified in the study. In addition, the average mass of the concrete specimens containing Kepahiang mountain stone was 12.11 kg, which was lower than the 12.75 kg recorded for specimens containing Sungai Lais river stone. This difference is consistent with the lower specific gravity of the mountain stone and indicates that its use can produce comparatively lighter concrete under the same mixture conditions. Therefore, Kepahiang mountain stone demonstrates potential as an alternative locally sourced coarse aggregate for concrete applications, particularly where reducing concrete mass may provide practical advantages; however, its suitability for construction on relatively weak soil should be established through further structural and geotechnical evaluation rather than inferred solely from the specimen mass.

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