The Potential of White Coral Stone as Concrete Aggregate: A Comparative Study Based on SNI Parameters

Euis Kania Kurniawati[1*], Restu Nurfalah[1], Tahadjuddin[1]
[1]Civil Engineering Department, Universitas Muhammadiyah Sukabumi
*Corresponding Author: Euis Kania Kurniawati. Email: euiskania@ummi.ac.id

ORCID: Euis Kania Kurniawati. https://orcid.org/0009-0007-0640-8946

Abstract

Concrete performance depends significantly on the characteristics of its constituent materials, particularly coarse aggregates. In this study, white coral stone sourced from Ciragil Village in Sukabumi, Indonesia, was examined as an alternative coarse aggregate for concrete. A series of laboratory tests were conducted to evaluate its physical properties, including moisture content, silt and clay content, water absorption, specific gravity, fineness modulus, and bulk density. These properties were compared to standard requirements outlined in the Indonesian National Standard and specifications from the American Society for Testing and Materials.

The test results revealed that white coral stone has high water absorption and silt content, along with low specific gravity, all of which fall outside standard limits for conventional concrete aggregates. These conditions suggest that the material is porous and lightweight, characteristics that may reduce the strength and durability of concrete if not properly addressed. However, through appropriate treatment methods such as washing, grading, and pre-saturation, white coral stone may still be viable for non-structural or lightweight concrete applications.

This research highlights the potential of utilizing locally available natural materials to support sustainable construction practices, especially in rural or economically constrained areas. It provides essential data for future studies and serves as a reference for alternative aggregate development in concrete production. Keyword : white coral stone, concrete aggregate, physical properties, sustainable materials, local resources

1. Introduction

In the field of construction materials, the selection of suitable aggregates plays a pivotal role in determining the mechanical performance, durability, and cost-effectiveness of concrete structures. Coarse aggregates, in particular, significantly influence the compressive strength, workability, and long-term integrity of concrete (1,2). While conventional crushed stone from granite or andesite is commonly used, there is growing interest in exploring locally available alternative materials that may provide economic and environmental benefits (3).

One such material is white coral stone, which is widely available in certain regions of Indonesia, such as Ciragil Village in Cidadap District, Sukabumi Regency. Due to its abundance and relatively low cost, local communities frequently use this material as an aggregate substitute in small-scale construction, including residential buildings and rural infrastructure. Despite its widespread use, the technical characteristics of white coral stone as a coarse aggregate have not been comprehensively evaluated, particularly when compared to established SNI (Standar Nasional Indonesia) requirements for concrete aggregates (4).

This study aims to examine the physical properties of white coral stone—such as specific gravity, absorption, bulk density, and gradation—and compare them with those of conventional aggregates and the thresholds outlined in SNI 03-2834-2000 and related standards (4). By assessing whether white coral stone meets the physical property criteria specified in national standards, the research seeks to determine its feasibility as an alternative aggregate material in concrete production.

The significance of this research lies in its potential to inform safer and more sustainable construction practices in rural and resource-limited settings. Additionally, the findings are expected to contribute to the body of knowledge in concrete technology, particularly regarding the utilization of non-conventional, locally sourced materials (2,3).

2. METHOD

2.1. Materials and Instruments

The primary material investigated in this study is white coral stone, used as coarse aggregate. Other coarse aggregates typically used in local construction were also evaluated for comparison. The study did not include cementitious binders, as the focus was solely on aggregate properties. Fine aggregates (natural sand) conforming to ASTM C33-03 (5) were used to support certain comparative analyses.
The instruments and equipment used include:

1. Sieve shaker and ASTM standard sieve sets (ASTM C136) (6)
2. Digital balance with 0.01 g accuracy
3. Oven (110 ± 5 °C) for drying samples
4. Pycnometer for specific gravity and absorption tests (7)
5. Volumetric cylinder molds for bulk density tests
6. Water tank and buckets for SSD and submerged weighing

All tests were conducted at the Construction Materials Laboratory of [Insert Institution Name], following national (SNI) and international (ASTM) standards (4-8).

2.2. Work Procedure

The research procedure followed a sequence of steps:

2.2.1. Sampling and Preparation

Aggregates were collected from Ciragil Village, Cidadap District, Sukabumi. The materials were air-dried, cleaned of organic matter, and then stored in sealed containers before testing.

2.2.2. Physical Testing

Each aggregate type was subjected to the following physical property tests:

1. Moisture Content: Tested using the oven-drying method according to SNI 1971:2011 (9).
2. Silt and Clay Content: Washed and measured as per SNI 03-4142-1996 (10).
3. Sieve Analysis: To determine gradation and fineness modulus using ASTM C136:2012 (6).
4. Specific Gravity and Water Absorption: Tested with pycnometer method in accordance with SNI 1969:2016 (7).
5. Bulk Density and Voids: Determined using SNI 03-4904-1998. Calculations included dry and SSD conditions.

2.2.3. Data Analysis

The values obtained were tabulated and compared against the standard requirements outlined in SNI 03-2834-2000 (4) and ASTM C33-03 (5). The analysis focused on identifying compliance or deviation of white coral stone characteristics with those prescribed in the standards.

2.2.4. Interpretation

Results were interpreted to evaluate the potential use of white coral stone as coarse aggregate. Deviations from the standard limits were discussed in relation to their possible implications on concrete properties such as strength, durability, and workability.

2.3. Reproducibility

To ensure reproducibility, all procedures followed standard methods with minimal modifications. Where adaptations were made, these are described in detail within the methodology. The equipment calibration was verified prior to each test, and triplicate testing was conducted to ensure data reliability.
Published test methods were cited accordingly, and all measurements were conducted under controlled laboratory conditions to minimize variability and ensure accuracy of results.

Table 1: Requirements for Grading Fine Aggregate Sieve Size Percentage Passing

Size of the sieve	Cumulative Passing Percentage
9,5	100
4,75	95-100
2,36	80-100
1,18	50-85
0,6	25-60
0,3	2-10
0,15	2-10

[a.] ASTM C33-03

3. RESULTS AND DISCUSSION

3.1. Overview of Laboratory Test Results

Table 3.1 below presents the physical property test results of the aggregate samples used in this study, which include Pasir BKP (white coral sand), Pasir Jebrod (local sand), Split BKP (white coral stone), and Split Fresh Beton (typical coarse aggregate from standard concrete mixture). The table also includes standard references and threshold values.

Table 2: Physical Properties of Fine and Coarse Aggregates

No	Parameter	BKP fine aggregate	Jebrod Fine Aggregate	BKP Coarse Aggergate	Fresh Beton Coarse Aggregate	Standard Requirement (SNI and ASTM)	Reference Standard
1	Moisture Content (%)	12,95	3,7	8,32	0,43	Max 2.0%	ASTM C566
2	Silt and Clay (%)	27,18	28,26	9,59	1,21	Max 5.0%	SNI 03-2834-2000
3	Fineness Modulus	4,47	5,19	3,6	3,36	2.3–3.1 (fine aggregate)	ASTM C33
4	Water Absorption (%)	11,94	7,49	14,89	2,6	Max 3.0%	ASTM C127/C128
5	Specific Gravity (SSD)	2,29	2,61	2,21	2,54	Min 2.50	ASTM C127
6	Bulk Density (Loose)	1,29	1,55	1,08	1,31	1.2–1.7 (typical range)	ASTM C29/C29M
7	Bulk Density (Compact)	1,69	1,69	1,26	1,47	1.4–1.8 (typical range)	ASTM C29/C29M

3.2. Discussion

3.2.1. Moisture Content and Water Absorption

White coral stone (Split BKP) shows a high moisture content (8.32%) and high water absorption (14.89%), far exceeding typical limits set by SNI 03-2834-2000 (4) and ASTM C33 (5. This high porosity indicates that white coral is a highly absorbent material, which may affect water-cement ratio calculations and require careful adjustment during mix design. Previous studies have similarly shown that aggregates with high absorption can negatively impact workability and strength if not properly accounted for (11)

3.2.2. Fineness and Gradation

The fineness modulus of Split BKP is 3.60, while Pasir BKP has a value of 4.47. Both values exceed the typical range specified by ASTM for fine aggregates, indicating that these materials are coarser and could influence workability. In comparison, conventional concrete mixes utilize aggregates with a modulus of fineness closer to the standard range to ensure proper)grading and packing (12)

3.2.3. Silt and Clay Content

Silt and clay content in Pasir BKP (27.18%) and Pasir Jebrod (28.26%) are significantly above the allowable limit of 5% according to SNI (4). This excessive content can compromise bonding and strength of the concrete, highlighting the necessity of washing before use. Similar conclusions were drawn in previous studies (13), where high silt content reduced compressive strength significantly.

3.2.4. Specific Gravity and Bulk Density

Split BKP has a lower specific gravity (2.21) and lower compacted bulk density (1.26 kg/m³) compared to conventional aggregates (2.54 and 1.47 kg/m³ respectively). Lower values suggest that white coral aggregates are lighter and more porous, which may result in lighter but potentially weaker concrete. These results are consistent with findings from similar studies using lightweight natural aggregates [14].

3.2.5. Implications for Concrete Use

The physical characteristics of white coral stone suggest it has potential for use in non-structural or low-strength applications. However, the high absorption rate and low density require adjustments in mix design. Pre-saturation and careful proportioning may be necessary to ensure performance. Despite these challenges, such local materials offer sustainability benefits when used with proper treatment and design adaptations.

3.3. Compliance with Standards

Compared to SNI and ASTM C33 thresholds:

1. Split BKP does not meet ideal limits for absorption and silt content.
2. However, with treatment (washing, grading, moisture control), it may be adapted for specific applications.
3. Further mechanical testing (e.g., compressive strength of resulting concrete) is recommended to confirm viability.
4. This evaluation provides a preliminary but critical understanding of the limitations and opportunities of using white coral stone as an alternative coarse aggregate.

4. Conclusions

This study evaluated the physical properties of white coral stone (Split BKP) as an alternative coarse aggregate in concrete by comparing it to local materials and standard requirements based on SNI and ASTM (4-8). The findings show that white coral stone exhibits high water absorption (14.89%), low specific gravity (2.21), and high silt content (9.59%), all of which fall outside the limits set by relevant standards. These characteristics indicate high porosity and reduced density, which may affect concrete performance.

Despite these limitations, with appropriate treatment such as washing and pre-saturation, white coral stone may still be feasible for non-structural or low-load applications. Its lightweight nature also suggests potential in lightweight concrete production, especially where sustainability and the use of local resources are prioritized. However, further mechanical performance evaluation, particularly compressive strength testing, is necessary before field application.

In summary, while white coral stone does not fully comply with standard aggregate specifications, its use may be justified in certain contexts where its unique properties can be effectively managed and leveraged.

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