

ANALYSIS OF THE UTILIZATION OF CERAMIC CRACKED WASTE AS A SUBSTITUTE FOR COARSE AGGREGATE IN K-325 GRADE CONCRETE (FC' 28.8 MPa)

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ABSTRACT

The growing demand for building supplies and the rise in construction waste are both impacted by the quick growth of infrastructure. One of the construction wastes that is quite abundant and has not been used to its full potential is ceramic shard trash. This study aims to analyze the effect of the use of ceramic shard waste as a partial replacement of coarse aggregate on the properties of fresh concrete and hardened concrete at the quality of K-325 (fc'28.8 MPa). The research method used is a laboratory experiment with variations in the substitution of coarse aggregate by ceramic shard waste of 0%, 10%, 20%, and 30%. The tests carried out include slump tests and concrete compressive strength tests at the age of 28 days. The results of the study showed that increasing the percentage of ceramic waste caused a decrease in the slump value, but all variations still met the workability requirements of concrete. The highest concrete compressive strength was obtained at 10% substitution of 353.25 kg/cm², higher than normal concrete at 325.33 kg/cm². At 20% and 30% substitution, the concrete compressive strength decreased. The results of this study indicate that ceramic waste fragments can be used as a substitute for coarse aggregate up to an optimal limit of 10% to produce K-325 quality concrete that meets technical requirements and supports the concept of sustainable construction.

Keywords: ceramic waste, coarse aggregate, K-325 concrete, compressive strength, slump

1. INTRODUCTION

1.1. Background

One of the industries that uses the most natural resources is the building sector, especially the natural aggregates used to make concrete. As the main building ingredient, concrete needs a lot of aggregate—roughly 70–75% of the total volume. Broken ceramics are among the substantial amounts of solid trash produced by construction and restoration projects (Mulyadi, Asri; Sanutra 2017). Waste ceramic shards are produced during building construction, installation, and

demolition. Inorganic, hard, and non-biodegradable, ceramic materials can harm the environment if they are disposed of improperly. Reusing ceramic waste is therefore necessary in order to add value and lessen its detrimental effects on the environment(Asri;et.al Mulyadi 2018).

As part of the reduce, reuse, and recycle (3R) philosophy, the use of ceramic waste as aggregate in concrete has been extensively researched. Ceramics have a rough surface and a strong compressive strength, which may strengthen their bond with cement paste. However, if ceramics are utilized in excess, their brittle nature may have an impact on the performance of concrete(Mulyadi, Asri;Suanto, Pengki ;Toni 2022). The purpose of this research was to examine the effects of utilizing ceramic waste in place of some of the coarse aggregate on the characteristics of both fresh and hardened concrete at K-325 quality ($f_c'28.8$ MPa).

1.2. Research Aim

The problems studied in this research include:

1. How does the slump value of K-325 concrete change when ceramic waste is used in place of coarse aggregate?
2. What is the impact on K-325 concrete's compressive strength when coarse aggregate is replaced with ceramic waste?
3. What percentage of ceramic shard debris replaces coarse aggregate to produce the best results?

1.3. Research Objectives

The objectives of this research are:

1. Analyzing the effect of using ceramic waste fragments on concrete workability.
2. To determine the effect of substitution of ceramic waste fragments on the compressive strength of K-325 grade concrete.
3. Determining the optimal substitution percentage of ceramic waste as coarse aggregate.

1.4. Reseach Benefits

This research is expected to provide benefits:

1. As a substitute for coarse aggregate in concrete.
2. Reducing construction waste and exploitation of natural aggregates.
3. As a reference for sustainable concrete research.\

2. LITERATURE REVIEW

2.1. Concrete and Concrete Quality

Cement, fine aggregate, coarse aggregate, and water make up the composite material known as concrete(Asri; et. al Mulyadi 2019). The compressive strength of concrete at 28 days, which is stated in MPa or class K, determines its quality.

2.2. Coarse Aggregates

The strength and stability of concrete are greatly influenced by the coarse aggregate that serves as a framework. The SNI standards for gradation,

cleanliness, and wear resistance must be met by good coarse aggregate (A. S. Mulyadi 2021).

2.3. Ceramic Shards Waste

Ceramic shards are a type of inorganic trash that is brittle, hard, and capable of absorbing some water. These qualities enable them to be utilized in specific ratios as a substitute coarse aggregate.

2.4. Previous Research

Several studies have shown that the use of ceramic waste as aggregate can increase compressive strength at low levels, but reduce workability and strength at high levels.

3. RESEARCH METHODOLOGY

3.1. Research Type

This research is a laboratory experimental research.

3.2. Mixed Variations

Variations of coarse aggregate substitution by ceramic waste:

1. BN : 0%
2. BK10 : 10%
3. BK20 : 20%
4. BK30 : 30%

3.3. Materials and Objects Test

The test object was a 15 x 15 x 15 cm cube. At 28 days of age, the compressive strength test was conducted.

3.4. Testing Method

1. Slump Test (ASTM C143)
2. Concrete compressive strength test (SNI)

4. RESULT AND DISCUSSION

4.1. Slump Test Result

The slump value of concrete decreases as the ceramic waste content increases:

Table 4.1. Slump Value (Source : Result of Slump Test Value)

No.	Concrete	Slump Value (cm)
1	Normal (BN)	9
2	With 10% ceramic waste from the weight of Split Stone (BK10%)	8,7
3	With ceramic waste fragments 10% of the weight of Split Stone (BK20%)	7,7

4	With ceramic waste fragments 10% of the weight of Split Stone (BK30%)	6
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This decrease is caused by the rough surface of ceramic waste and higher water absorption capacity.

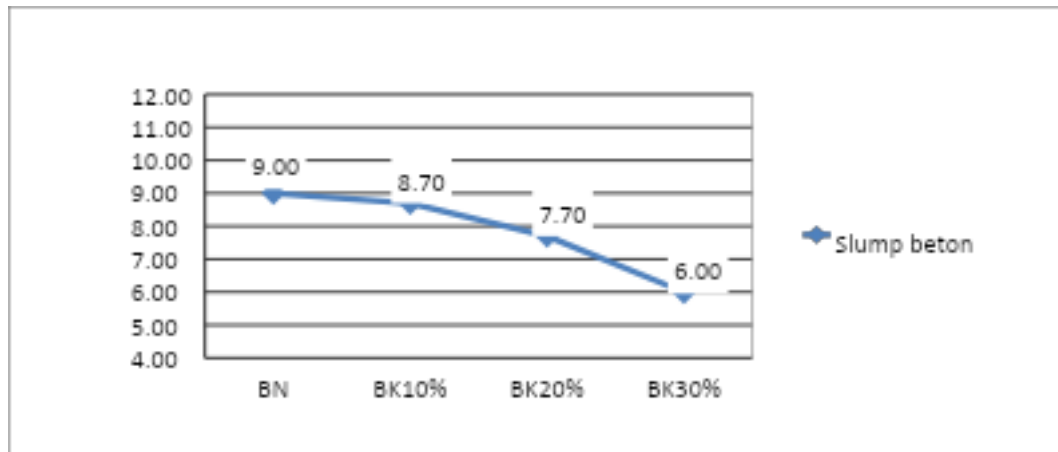


Figure 4.1. Graph of Slump Value
Source : Result of Slump Test Value

4.2. Compressive Strength Test Results

Results of the compressive strength test of 28-day-old concrete:

Table 4.2. Compressive Concrete Strength Test (Source: Result Of Compressive Concrete Strength Testin 28-Day-Old.

No.	Concrete Quality K-325	Average orf σ Destroyed (kg/cm ²)
1	BN	325,33
2	BK 10	353,25
3	BK 20	301,93
4	BK 30	281,55

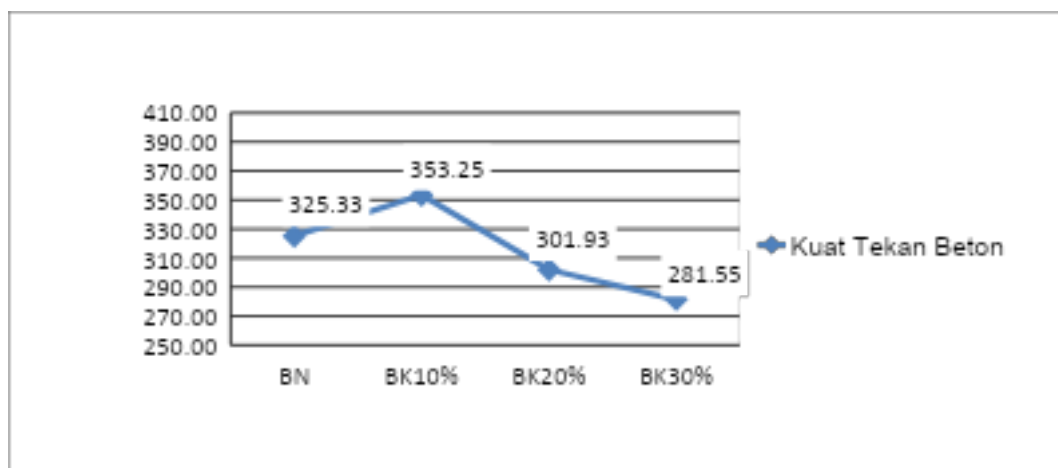


Figure 4.2. Graph of Compressive Concrete Strength Test
Source : Result Of Compressive Concrete Strength Testin 28-Day-Old.

Because of improved aggregate-cement paste interlocking and bonding, a 10% substitution produces the best compressive strength. Because ceramics are brittle, compressive strength drops at increasing replacements.

4.3. Discussion

According to the study's findings, leftover ceramic shards can be partially utilized as coarse aggregate. Compressive strength is increased with an ideal substitute of 10% without appreciably decreasing workability. This result is consistent with the sustainable concrete and construction waste utilization concepts.

5. CONCLUSSION AND SUGGESTION

5.1. Conclusion

1. The slump value is decreased when ceramic waste particles are substituted, but the concrete workability standards are still met.
2. The compressive strength of K-325 concrete is increased by substituting 10% ceramic waste.
3. Concrete's compressive strength is greatly decreased with substitutions more than 20%.
4. 10% is the ideal proportion to use ceramic waste as coarse aggregate.

5.2. Suggestion

1. The durability of concrete made from ceramic waste requires more investigation.
2. To increase workability, ceramic waste can be combined with chemical additives.
3. To determine whether implementation in the field is feasible, economic and environmental analysis is advised.

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