

ANALYSIS THE APPLICATION OF GLASS LIGHTBALL WASTE AS A FINE AGGREGATE SUBSTITUTION IN K-175 GRADE CONCRETE MIXTURE (14.5 MPa)

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ABSTRACT

Serious environmental issues are brought on by the growing use of light bulb glass debris as non-biodegradable inorganic trash. Using it as a building material is one way to handle trash sustainably. The purpose of this study is to examine how the properties of FC 14.5 MPa (K-175) quality concrete are affected when light bulb glass debris is used as a partial replacement for fine aggregate. A laboratory experiment with variations in glass waste substitution of 0%, 4%, 6%, and 8% of the fine aggregate weight was the research methodology. Slump tests, concrete specific gravity, and concrete compressive strength after 28 days were all tested. The slump value decreased as the amount of glass waste increased, but it remained within the workability standard limitations, according to the data. With a maximum value of 255.13 kg/cm² at 6% variation, the concrete's compressive strength rose at 4% and 6% substitution before falling at 8% substitution. The study's findings indicate that 6% of the fine aggregate weight is the ideal replacement proportion for lightbulb glass trash. According to this study, recycled lightbulb glass may be utilized in low-quality concrete as an eco-friendly substitute.

Keywords: light bulb glass waste, K-175 concrete, fine aggregate, compressive strength, workability

1. INTRODUCTION

Concrete is becoming more and more popular as a key building material due to rapid infrastructural development. Because of its great compressive strength, longevity, and ease of field application, concrete is the preferred material. However, the overuse of natural aggregates and higher carbon emissions from cement manufacture are the results of this high concrete use (Asri Mulyadi; Saloma; Siti Aisyah Nurjannah, 2025). However, a significant amount of glass trash has been produced by the growing use of glass-based items, especially light bulbs. Glass debris from light bulbs is not biodegradable and takes a very long time to break down naturally. This trash has the potential to contaminate the environment and endanger human health if improperly managed (Mulyadi, 2018).

Glass debris has a significant silica concentration, which could help improve the mechanical qualities of concrete when employed in specific amounts, according to several studies. It is anticipated that using glass trash in place of fine aggregate will cut waste, preserve natural resources, and promote sustainable building practices.

The application of waste glass light bulbs as a partial replacement for fine aggregate in FC 14.5 MPa (K-175) concrete, which is frequently utilized in non-primary and simple building construction, is the main topic of this study. It is anticipated that this research will contribute both scientifically and practically to the use of glass waste in civil engineering (Mulyadi, 2019).

2. LITERATURE REVIEW

2.1. The Components of Concrete

Concrete is a solid mass with a certain strength that is created by hydrating a mixture of cement, fine aggregate, coarse aggregate, and water. The quality and ratios of the ingredients that make up concrete have a big impact on its properties.

2.2. The Aggregates-Concrete

Aggregates served 60–80% of the volume of concrete and act as its framework. Proper gradation, a normal specific gravity, a low silt content, and regulated water absorption are all characteristics of good aggregates (Asri Mulyadi, Saloma, 2024).

2.3. The Waste Glass Light Bulbs

Silica (SiO_2), which is strong and difficult to breakdown, makes up the majority of light bulb glass waste. Glass debris may be used in place of fine aggregate once it has been crushed to a specific size (Asri Mulyadi, 2020).

2.4. The Effect of Glass Waste on Concrete

Concrete density can be increased and compressive strength may be somewhat increased by using glass waste. On the other hand, overuse can make the concrete less workable and more brittle.

3. RESEARCH METHODOLOGY

3.1. Research Types and Methods

The purpose of this study, which is a lab experiment, is to ascertain how specific treatments affect the characteristics and functionality of concrete. The experimental approach was selected because it enables researchers to methodically manipulate the research variables, enabling a precise and quantifiable examination of the causal links between them.

3.2. Ingredients and Mixture Variations

Portland cement as a binder, fine aggregate, coarse aggregate, water, and leftover lightbulb glass—which served as a partial replacement for the fine aggregate—were the materials utilized in this investigation. To make sure they satisfied the tangible quality requirements of relevant standards, all materials were put through a physical property test in the lab.

The following modifications in the substitution of light bulb glass trash used in this investigation are stated as a percentage of the weight of fine aggregate:

1. 0% waste glass light bulbs (control: regular concrete),
2. 4% of glass waste from light bulbs
3. 6% of glass waste from light bulbs, and
8% of glass waste from light bulbs.

3.3. Testing Preparation and Maintenance

The testing were 15 x 15 x 15 cm cubes. Concrete materials were mixed in accordance with the intended mixture composition for each variant of light bulb glass waste substitution before test specimens were manufactured. The test specimens were taken out of the mold (demolding) and cured by submerging them in water once the concrete had attained its initial hardening. Until the test age of 28 days was achieved, this therapy was administered for 27 days.

3.4. Testing

In this research, tests were carried out to ascertain the properties of both fresh and hardened concrete as a result of differences in the replacement of waste light bulb glass. The examinations conducted comprised:

1. Slump test (SNI 1972:2008).
2. Compressive strength test of concrete after 28 days (SNI 1974:2011).
3. Specific gravity test for concrete.

4. RESULT AND DISSCUSION

4.1. Material Characteristics

The characteristics of the concrete components used in this research were obtained through a series of laboratory tests on fine and coarse aggregates. The fine aggregates used came from the Musi River, while the coarse aggregates came from Lahat. The test results showed that the Musi River fine aggregates had good grain gradation, specific gravity and water absorption that were still within the permitted limits, and mud content that met the provisions of the Indonesian National Standard (SNI). and the Lahat coarse aggregates also showed test results that met SNI specifications, both in terms of gradation, specific gravity, water absorption, and resistance to wear.

4.2. Concrete Workability

According to SNI 1972:2008, slump testing was used in this investigation to assess the workability of the concrete. The purpose of this test is to ascertain the fresh concrete's workability level in each variation of lightbulb glass waste substitution and to guarantee the concrete's ease of workability throughout the casting process. The concrete slump value shows a decreasing trend as the percentage of light bulb glass waste increases, however, all mixture variations are still within the required slump value range of 60–100 mm.

Table 4.1. The correlation between the slump value and the percentage of glass waste (Source : Research Result of Slump Test Concrete K175)

No.	Concrete	Slump Value (cm)
1	Normal (BN)	10
2	Glass light bulb trash makes for 4% of the sand's weight (BB4%).	9,3
3	6% of the weight of sand is made up of used glass light bulbs (BB6%).	8,7
4	8% of the weight of sand is made up of waste glass light bulbs (BB8%).	8

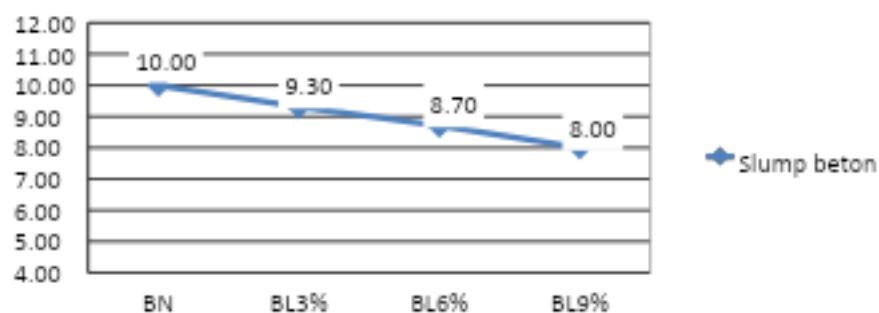


Figure 4.1. Graph of the relationship between the percentage of glass waste and the slump value

Source : Research Result of Slump Test Concrete K175

4.3. Concrete Compressive Strength

In compliance with SNI 03-6805-2002, a cube-shaped test specimen measuring $15 \times 15 \times 15$ cm was used to test the compressive strength of concrete after 28 days. The purpose of this test is to ascertain how different light bulb glass waste substitutions affect concrete's capacity to sustain compressive stresses.

Table 4.2. Results Of Concrete Compressive Strength Test (Source : Results Of Concrete Compressive Strength Test K175)

No.	Concrete Quality 14.5 Mpa (K175)	Average σ Destroyed (kg/cm ²)
1	BN	175,12
2	BL4%	194,74
3	BL6%	255,13
4	BL8%	181,16

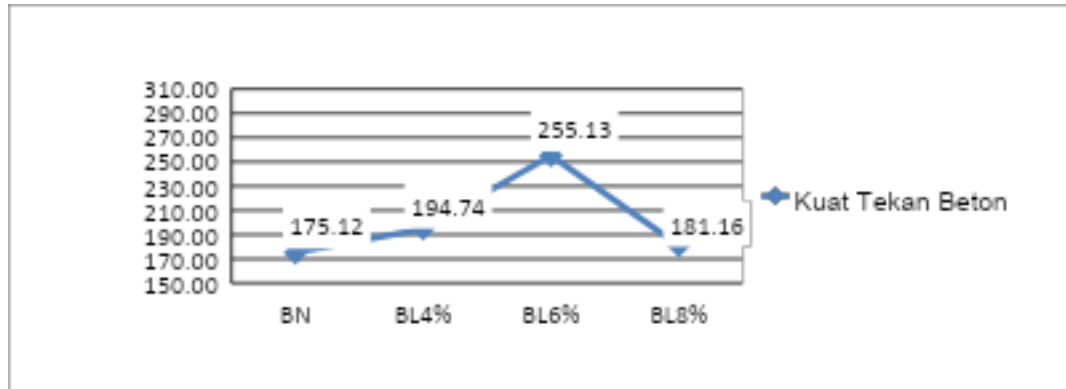


Figure 4.2. Graph of The Results Of Concrete Compressive Strength Test
Source : Results Of Concrete Compressive Strength Test K175

At substitution variations of 4% and 6%, concrete's compressive strength improved dramatically, reaching its maximum value at 6% substitution. Compressive strength dropped at 8% substitution as a result of reduced concrete workability and cement paste efficacy.

4.4. Discussion

The research's findings demonstrated that substituting light bulb glass waste up to a specific percentage limit improved concrete performance, particularly compressive strength, suggesting that light bulb glass waste might be used as a substitute ingredient in concrete mixtures.

5. CONCLUSSION AND SUGGESTION

5.1. Conclusion

1. Concrete's workability and compressive strength are impacted by lightbulb glass trash.
2. A content of 6% of the fine aggregate weight yields the ideal substitution percentage.
3. Every combination variation satisfies the f_c 14.5 MPa concrete quality standard (K-175).
4. An eco-friendly substitute material might be made from used glass light bulbs.

5.2. Suggestion

1. Further research is recommended to examine the durability aspects of concrete.
2. More research is required to understand variations in the size of glass waste grains.
3. Application at the field scale is advised.

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