Variations of Crushed Stone Sand and Bottom Ash as a Substitute for Sand to Increase the Compressive Strength of Concrete

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Abstract. Concrete is one of the construction structures used in construction, which is made of coarse aggregate like crushed stone, fine aggregate like sand, portland cement, water, and addictive substance like superplasticizers if needed which are mixed. In this study, the designed for concrete is the fine aggregate is a mixture from rock ash and bottom ash, the rest of materials are the same. With the current infrastructure development, the need for sand will be increasingly and this sand material will be increasingly depleted. The percentage in this study use rock ash and bottom ash is 75% rock ash and bottom ash is 25% of the variation in the volume ratio between waste materials and fine aggregate required. This study will use the following variations: Normal concrete (0% AB and 0 and 0% BA; 95% AB: 5% BA; 90% AB: 10% BA; 85% AB: 15% BA; 80% AB: 20% BA; 75% AB: 25% BA. From the results of the tests that have been conducted, the normal concrete compressive strength values are obtained at the age 28 days is 317.19 kg/cm^2. The compressive strength of concrete using a mixture of rock ash (95%) and bottom ash (5%) at ages 28 days is 361.90 kg/cm^2. For the compressive strength of concrete using a mixture of rock ash (75%) and bottom ash (25%) at ages 28 days, namely 303.85 kg/cm^2. So, the strength of concrete can decrease if the concrete mix is added with the percentage of bottom ash.

Keywords: Crushed Stone Sand · Bottom Ash · Concrete Age · Concrete Compressive Strength

1 Introduction

Concrete is a mixture of materials consisting of coarse aggregate, fine aggregate, portland cement, and water. Concrete is not able to withstand tensile strength, in conducting structural construction building it is necessary to install steel reinforcement to the concrete.

With the increasing growth in infrastructure development every year, the need for fine aggregate material will increase and will decrease. Therefore, in this study to make a concrete using a rock ash and bottom ash. The percentages used in this study were the use of stone ash by 75% and bottom ash by 25% from the variation in the volume ratio between waste material and fine aggregate (sand) required. By utilizing this waste, it can

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be used as a substitute for sand into the concrete mixture. Thus, it can have a positive impact on the sustainability of infrastructure by making efficient use of sand. The main component in the structure of a road pavement is aggregate, with 90% to 95% aggregate by weight or 75% to 85% aggregate by volume [1].

1.1 Aggregate Classification

1.1.1 Based on Aggregate Size and Production

Coarse aggregate and fine aggregate have differences in size where the size is determined from the sieve, namely the sieve, 6.35 mm or 3/16. Fine aggregate has a size smaller than 6.35 mm and coarse aggregate has a size of more than 6.35 mm [2].

1.1.2 Types of Aggregates by Source

a. Processed Aggregate
The aggregate used is rock that has been broken down and screened before. Aggregate splitting is done because:

- To change the shape of the particle to be angular.
- Reduced and increased particle size distribution and range.

b. Artificial Aggregate
Artificial aggregates can come from physical or chemical processes and a mixture of several materials that can produce new materials that have aggregate-like properties. Several types of aggregate production are the result of by-products of industrial processes and material processes that are intentionally made to be reused as aggregate or as mineral filler (filter) [3].

1.2 Concretev

Concrete is a construction structure made from a several materials such as aggregate, with a binder such as Portland cement, and then added with water so that the cement can react to become a paste that binds aggregate grains so that it becomes a solid construction material that cannot dissolve in water [4].

1.2.1 Concrete Properties

1. Fresh concrete properties

Fresh concrete is concrete which is a mixture of water, cement, aggregate and supporting materials if needed in a plastic state or before the cement binds. The environment is one of the factors that can worsen the workability of concrete. Environmental conditions such as temperature, humidity, and wind speed at the location are factors that can worsen the properties of concrete. The workability of concrete is related to the time it can deteriorate so that concrete can result directly from the loss of free water through mixing. In addition to being easy to work with, fresh concrete must have a stable composition of the mixture

that is evenly distributed from mixing the concrete mixture to compaction of the concrete, before the cement in the concrete binds.

2. Properties for hardened concrete

For the properties of concrete when fresh is especially important after the process of mixing the concrete mixture. The strength properties of concrete are especially important because concrete must be able to withstand the planned maximum load, so other properties will improve as well [5]. Tensile testing on concrete has two types of tests, the first is the split tensile strength test of concrete which is called the azilian tensile test and the direct tensile test of concrete which is called the direct tensile strength [4].

1.3 Crushed Stone Sand

In ancient times crushed stone sand was used as the initial layer before the asphalt concrete layer in the construction of the macadam penetration layer or road surface layer. However, in modern times like today, crushed stone sand is rarely used in big cities, because road pavement construction using road surface layer has shifted to asphalt-concrete layers. Even so, in many areas stone ash is still the main material in paving construction. Crushed stone sand can also be used as a substitute for sand to make concrete.

2 Methodology

2.1 The Scope of Research

The source of the material used is cement produced by PT. Baturaja, coarse aggregate from the Lahat area, Bottom Ash from PT. PUSRI Palembang, and fine aggregate from the Tanjung Raja area.

2.2 Data Collection

The results obtained after evaluating the properties of the materials used meets the applicable Indonesian National Standard (SNI) requirements, then it can be continued with the manufacture of 72 concrete cube test objects.

2.3 Data Analysis

The results of evaluating the compressive strength of concrete for each use of palm shells and additives will be included in a table and a graph of the results of the compressive strength test of concrete will be made.

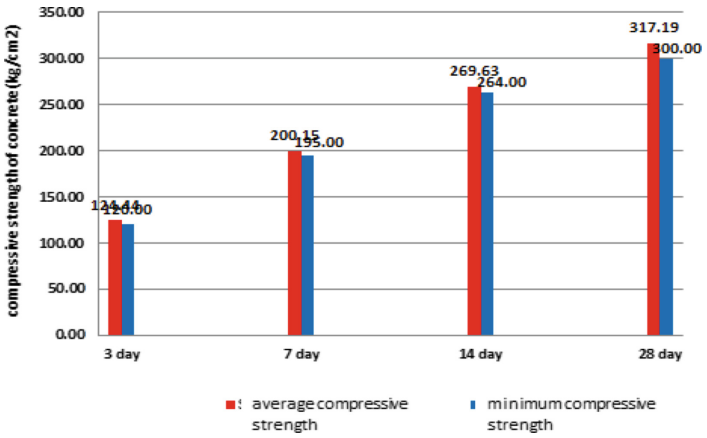

Fig. 1. Comparison of Concrete Compressive Strength without Crushed Stone Sand and Bottom Ash

3 Result and Discussion

3.1 Test Results and Comparison of Concrete Compressive Strength Without Rock Ash and Bottom Ash

With the percentage of coconut shell with the percentage of coral, the compressive strength was obtained, respectively: 124.44 kg/cm^2, 200.15 kg/cm^2, 296.63 kg/cm^2, and 317.19 kg/cm^2. This shows that the concrete without using Crushed Stone Sand and Bottom Ash, or normal concrete meets the compressive strength of concrete characteristics of K-300 (Fig. 1).

3.2 Concrete Test Results at with a Ratio of Stone Ash (AB) and Bottom Ash (BA), (AB = 95%) / (BA = 5%)

From the results, the data obtained is 361.90 kg/cm^2 and meets the planned concrete compressive strength of 300 kg/cm^2 at 28 days old (Fig. 2).

3.3 Concrete Test Results with a ratio of Stone Ash (AB) and Bottom Ash (BA), (AB = 90%) / (BA = 10%)

From the results, the data obtained is 355,11 kg/cm^2 and meets the planned concrete compressive strength of 300 kg/cm^2 at 28 days old (Fig. 3).

3.4 Concrete Test Results with a ratio of Stone Ash (AB) and Bottom Ash (BA), (AB = 85%) / (BA = 15%)

From the results, the data obtained is 350,96 kg/cm^2 and meets the planned concrete compressive strength of 300 kg/cm^2 at 28 days old (Fig. 4).

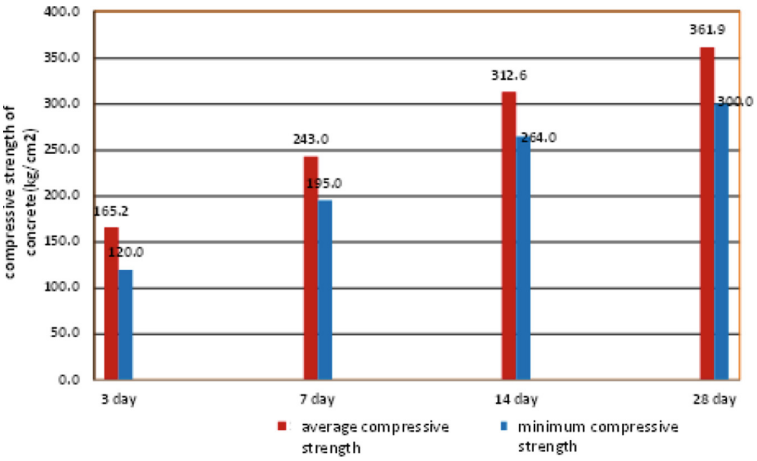

Fig. 2. Comparison of Concrete Compressive Strength using the Ratio of Crushed Stone Sand (AB = 95%) and Bottom Ash (BA = 5%)

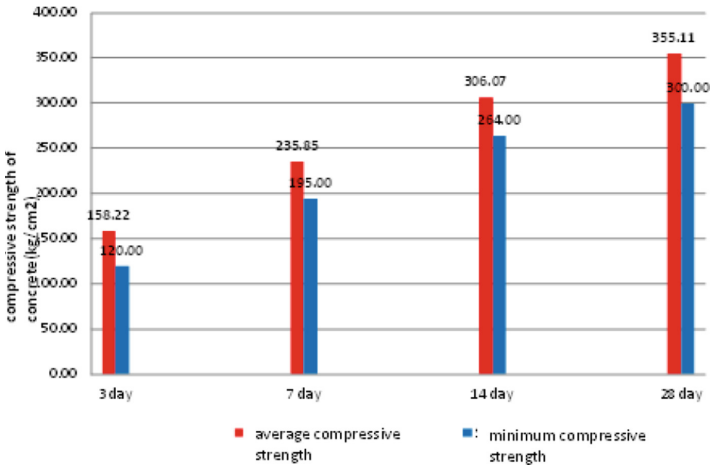

Fig. 3. Comparison of Concrete Compressive using the Ratio of Crushed Stone Sand (AB = 90%) and Bottom Ash (BA = 10%)

3.5 Concrete Test Results with a ratio of Stone Ash (AB) and Bottom Ash (BA), (AB = 80%) / (BA = 20%)

From the results, the data obtained is 342,37 kg/cm^2 and meets the planned concrete compressive strength of 300 kg/cm^2 at 28 days old (Fig. 5).

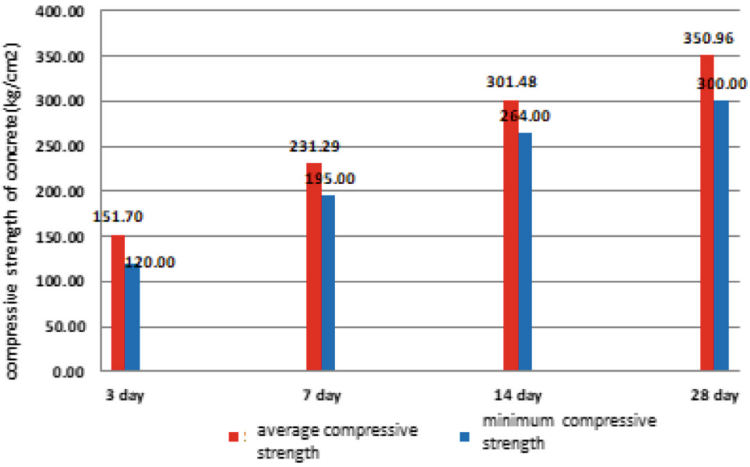

Fig. 4. Comparison of Concrete Compressive Strength using the Ratio of Crushed Stone Sand (AB = 85%) and Bottom Ash (BA = 15%)

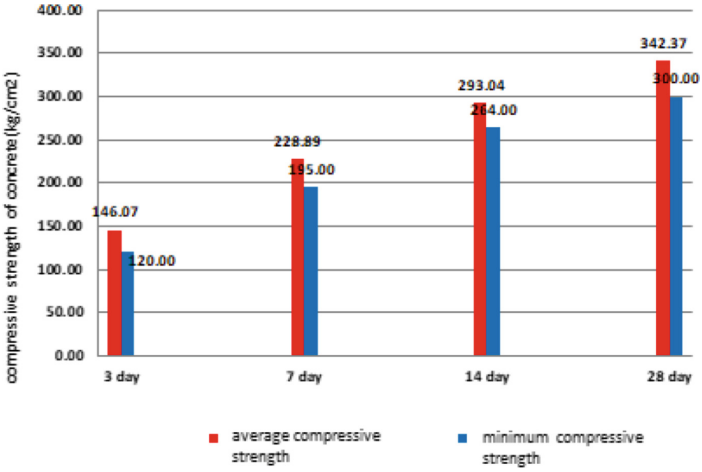

Fig. 5. Comparison of Concrete Compressive Strength using the Ratio of Crushed Stone Sand (AB = 80%) and Bottom Ash (BA = 20%)

3.6 Concrete Test Results with a ratio of Stone Ash (AB) and Bottom Ash (BA), (AB = 75%) / (BA = 25%)

From the results, the data obtained is 303,85 kg/cm^2 and meets the planned concrete compressive strength of 300 kg/cm^2 at 28 days old (Fig. 6).

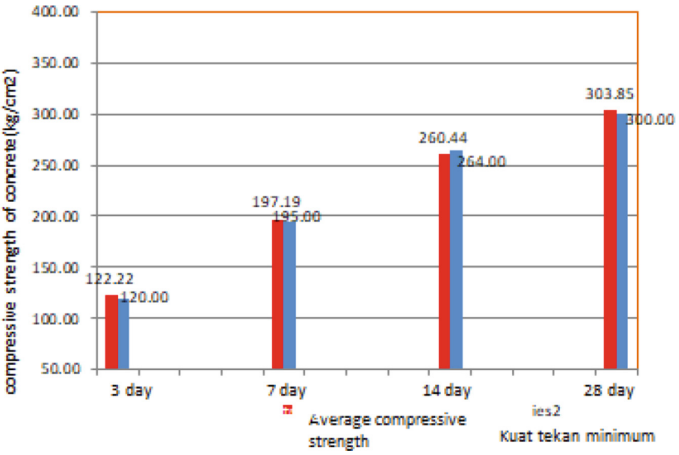

Fig. 6. Comparison of Concrete Compressive Strength using the Ratio of Crushed Stone Sand (AB = 75%) and Bottom Ash (BA = 25%)

4 Conclusion

The composition of the concrete mix made in this study was done by volume comparison between rock ash (AB) and bottom ash (BA) with a variation of 0% AB: 0% BA; 95% AB: 5% BA; 90% AB: 10% BA; 85% AB: 15% BA; 80% AB: 20% BA; 75% AB: 25% BA. From the research and analysis conducted in this study, it can be concluded that the more use of the percentage of bottom ash for concrete mixtures, the compressive strength of concrete can decrease.

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