

COMPRESSIVE STRENGTH OF RICE HUSK ASH AND PAPER WASTE AS A SUBSTITUTE FOR CEMENT

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Abstract

The Use of rice husk in concrete loading has been widely carried out, the function of rice husk ash varies, there is a concrete mixture added, and there is also a partial replacement of SCM (Supplementary Cementitious Material). Rice husk has a very dominant chemical content of SiO₂, as we know in the chemical content of cement SiO₂ and CaO are very important. In this study combining rice husk ash and paper waste ash, paper waste ash has a dominant chemical content, namely CaO. This study wanted to conduct an experiment on the Use of rice husk ash and paper waste ash as a substitute for the designation of SCM cement. This study combines rice husk ash and paper waste ash, with various types of compositions of 2.5%, 5%, and 7.5% of two materials made of cylindrical concrete specimens of 150 mm × 300 mm size with a compressive strength plan at the age of 28 days to 25 MPa, and made from 0% specimens (without ash) from the compressive strength test results obtained compressive strength results of a mixture of rice husk ash and paper ash at a composition of 7.5% obtained compressive strength results in 27.8 MPa, and 27.2 MPa, while the comparative test object 0% obtained 25.1 MPa, rice husk ash, and paper ash can be used as an alternative substitute for part of SCM cement.

Keywords: Aggregate, concrete, additive, high compressive strength

Introduction

Garbage is of course inevitable from our daily lives with a population of 200 million people in Indonesia, resulting in more waste in Indonesia. In August 2018, it was noted that the amount of waste in Indonesia reached 65 million tons, 10% of which came from used paper (Kementerian lingkungan hidup, 2018).

Many people have started to recycle paper waste, but the amount is still very small, so that a lot of paper waste eventually burns to unused ash, this research provides a solution on how to reduce paper waste and ash from burning, so that waste paper has

the potential to be utilized and possessed. Economic value.

Previous research to utilize waste products in communities such as study entitled Effect of Addition of Rice Husk Charcoal on Concrete Compressive Strength (Subandi *et al.*, 2019b), Utilization of Ironwood Waste and Husk Charcoal to Produce Lightweight Concrete (Subandi, *et al.*, 2019d), and Artificial Aggregate Lightweight Structural (Subandi, *et al.*, 2019a).

Rice husk has been investigated for its Use in connection with concrete mixtures, which function, such as mixed materials in place of cement, and

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many others. The Use of rice husk ash as a substitute for some of the cement has been examined, including Concrete Making with Artificial Sand from Rice Husk Waste (Subandi *et al.*, 2019c), Use of rice husk ash in concrete (Gupta and Wayal, 2015), Use of Rice Husk Ash for Partial Substitution with Cement in Concrete - Overview (Ghosal and Moulik, 2015), experiments using fly ash and rice husk ash in the production of high-quality concrete is also able to provide additional strength that reached 76 MPa (Lam *et al.*, 2018a), Effect of rice husk ash and fly ash on the compressive strength of high-performance concrete (Akeke *et al.*, 2013), Concrete making by adding rice husk ash and superplasticizer is able to increase the strength of concrete (Lam, *et al.*, 2018b), Chemical content of rice husk ash is presented in Table 1.

Table 1. Chemical content in rice husk ash and paper ash

Chemistry	Composition Rice husk ash	Composition Paper ash
SiO ₂	86,91	2,63
Al ₂ O ₃	0,5	0,60
Fe ₂ O ₃	0,87	0,71
CaO	1,04	92,70
MgO	0,85	1,19
Na ₂ O	0,69	1,22
K ₂ O	3,16	0,49

The same thing happened in research examining the Use of paper ash, and rice husk ash as a powder in a mixture making its own self-consolidating concrete (SCC). Paper ash and rice husk ash used as a mixture can add strength to the concrete (Krisnamurti, 2008). Chemical content in rice husk ash, which is rich in SiO₂ that is also can be found in the ordinary cement.

While testing the chemical content of ash derived from HVS (Hour Vrij Schrijfpapier) waste paper ash according to (Subandi *et al.*, 2020), the chemical content found in the most dominant paper waste ash was CaO (lime) reaching 92.70%. While SiO₂ is only 2.63%. The ash content of paper waste is contrary to the chemical content of rice husk ash. The chemical content of used paper ash sees Table 2.

The Use of waste paper in the construction industry is starting to increase, such as making

panels for furniture using paper waste from a newspaper (Amelia *et al.*, 2018), the Use of pulp waste and fly ash in bricks with a mixture of pulp waste 50% out of the weight of the sand and 10% fly ash produced a compressive strength of concrete blocks of 47.0474 Kg/cm², (Lianasari and Paiding, 2013).

In our study, to determine the Effect of the Use of rice husk ash (AP) and paper ash waste (later called AK) both materials are used to reduce the need for cement. Variation composition 0%, AP 2.5% + AK 7, 5%, AP 5% + AK 5%, and AP 7.5% + AK 2, 5%, each composition is made into nine cylindrical specimens, the weight of the addition of both materials. This will reduce the amount of cement used, so how much weight of both ingredients in each variation of the mixture will reduce the cement by the same amount, then undergo a compressive strength test when they are 7 days, 14 days, and 28 days old. this aims to find out how much cement weight can be reduced by replacing, with both ash materials. With the high chemical content of SiO₂ in rice husk ash and CaO chemical content which is also high in paper ash, it is hoped that both materials will be able to replace some of the cement.

Materials and Methods

Manufacture of Ash

Making rice husk ash is done manually by burning rice husk into a drum, rice husk is burned until rice husk turns to ash, combustion temperatures occur between 300°-400°. The burning process for 5 kg of rice husk takes approximately 7 h. After the rice husk has turned to ash, the ashes are filtered, using filter No 150, then weighed to find out the weight, density, and absorption. The process of making waste paper ash is the same as the manufacture of rice husk ash, by collecting raw material waste paper then putting it into a drum and after that, burning all paper in a temperature range between 500°-700°, the combustion process of 8 kg takes 1.6 h, then the paper ash sifted using filter No. 150, so that apart from all used paper that has been burned on average can produce 10% ash, the ash undergoes the same test as paper ash.

Table 2. Mix design

Test object code	Planned compressive strength for normal concrete (mpa)	Cement (kg)	Coarse aggregate (kg)	Fine aggregate (kg)	Water (kg)	Rice husk ash	Paper ash
BN	25	387	1038	692	205		
A2.5	25	337	1038	692	205		
A.5	25	337	1038	692	205		
A.7.5	25	337	1038	692	205		

Material Testing

Filtering Test and coarse and fine aggregate testing used the method Of weighing the content (SNI 03-4804-1998, 1998), and air cavity testing, density and absorption testing (SNI 03-1970-1990, 1990), and aggregate sludge testing (Astm, 2012).

Admixture Design and Test Specimens Manufacture

In this study, the researcher used 4 experiments: BN, A2.5, A5, and A7.5. Mix design sees Table 2.

From Table 2, the normal concrete mix design for the variation of the experiment will be mixed with an admixture of AP and AK, the percentage of the weight of cement as described below:

- BN: addition = 0%
- A2.5: AP 2.5%, AK 7.5% of cement weight = 10.25 kg + 30.75 kg
- A5: AP 5%, AK 5% of cement weight = 20.5 kg + 20.5 kg
- A7.5: AP 7.5%, AK 2.5% of cement weight = 30.75 kg + 10.25 kg

Cement reduction in each variation of the mixture is described as follows:

- BN: addition = 0%
- A2.5: 50 kg
- A5: 50 kg
- A7.5: 50 kg

From the results of the cement reduction above, that the cement is reduced by 50 kg for each variation, the only difference is the addition of rice husk ash and paper ash.

The planned slump was 50 mm - 100, for the test specimens making.

Making Test Objects and Testing Methods

Preparation and maintenance of test specimens according to Indonesian National Standards (SNI 03-2834-2000, 2000), (SNI 03-4810-1998, 1998). There were 36 test specimens. The experiments were carried out with a composition of 0% (Test object code BN), AP 2, 5% + AK 7, 5% (Test object code A2.5), AP 5% + AK 5% (Test object code A5), and AP 7, 5% + AK 2, 5% (Test object code A7.5), each composition was made into nine cylindrical specimens 150 mm × 300 mm, then had underwent compressive strength tests as they aged at 7 days, 14 days, and 28 days.

Deterioration test is carried out to determine the freshness of fresh concrete. The test concrete mixture is put into a cone and compacted with a piercing rod. The mold is lifted, and the mortar is left until the top surface of the concrete has a maximum decrease. measure the distance between the initial surface position and after the fall, in the middle of the top surface of the concrete, is

measured and reported as a concrete reduction value. (SNI-1972-2008, 2008).

Testing is done by following calculation procedures and methods ACI (ASTM- C39/C39M-18, 2018).

Results and Discussion

The results and discussion of this study will be elaborated in the following passage.

The Result of Test Specimens Testing

From the results of coarse aggregate test, the density is 2.53; the content weight is 1543 kg/m³, the fine aggregate density is 2.43 and the content weight is 1,621 kg/m³; rice husk ash with the density of 3.1, and the content weight is 631 kg/m³; and paper waste ash with the density of 2.91 has content weight of 693 kg/m³. Preparation and maintenance of test.

Slump Test Result

The results of the slump test are varied. Test specimens with BN code had result of specimen of 70 mm with A2.5 obtained consistency at 35 mm, specimens with A5 code got 30 mm consistency, and specimens with A7.5 code obtained slump result of 29.5 mm consistency.

Based on observation and test results of BN test specimens, it was still around the planned slump of 50 mm - 80 mm while the specimens with codes A2.5, A5, and A7.5 have high consistency due to the addition of admixture.

Compressive Strength Test

The results of the concrete compressive strength test for each sample are presented in Figure 1.

Discussion

From the results of the compressive strength test carried out, the test object with the BN code is in

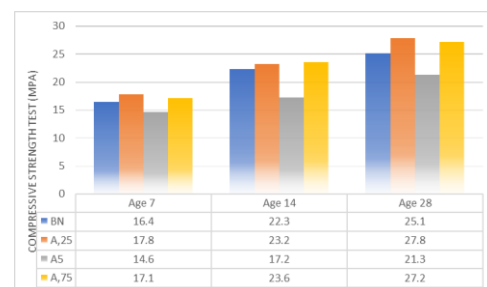


Figure 1. Compressive Strength Test (MPa)

accordance with the mixed design design, compressive strength of 7 days = 16.4 MPa, age 14 days = 22.3 MPa, and age 28 days = 25.1 MPa, the results are concrete with this BN code is in accordance with the mixed design.

While concrete with A2.5 code has a higher strength than normal concrete (BN), from the ages of 7, 14, and 28 days the strength of this concrete has better strength than normal concrete, the results of the A2.5 concrete strength test at age 28 days resulted in a concrete compressive strength of 27.8 MPa.

Whereas for specimens with A5 code, compressive strength results were 21.3 MPa at 28 days, these specimens used a mixture of ingredients added to 5% rice husk ash, and 5% waste paper ash by weight of cement, A5 specimen code reduced the compressive strength Compared with BN, A2.5, and A7.5 specimens, the dominant chemical constituents of SiO_2 , and CaO in these specimens are 50% each.

Test specimens with the A7.5 code yield compressive strength obtained 27.2 MPa, the code with this test specimen, using an additional mixture of rice husk ash by 7.5%, and ash from paper waste 2.5%. This result, when compared with previous test specimens, has the same relative strength as AA5 test specimens. The dominant chemical content in this specimen, 7.5% SiO_2 and CaO of 2, 5%, decreased concrete compressive strength.

The test object with code A2.5 has a better initial strength because in this concrete, 7.5% paper ash and 2.5% rice husk ash are added, high CaO content or $3\text{CaO} \cdot \text{SiO}_2$ compounds can accelerate the hydration process that occurs. in cement so that the initial strength is higher while SiO_2 or $2\text{CaO} \cdot \text{SiO}_2$ compounds. effect on the final power. The most dominant cement composition which gives cement properties is tricalcium silicate ($3\text{CaO} \cdot \text{SiO}_2$) and dicalcium silicate ($2\text{CaO} \cdot \text{SiO}_2$). The cement slurry resulted from mixing paper ash and silica from rice husk ash contains a very hygroscopic mixture. When cement, lime paper ash and silica rice husk ash can be operated/reacted with water is called the hydration process, and the result is called cement hydration. If exposed to air, the $3\text{CaO} \cdot \text{SiO}_2$ compound reacts quickly and produces heat, while the $2\text{CaO} \cdot \text{SiO}_2$ compound reacts more slowly with air and only affects cement after 7 days of age.

The Use of these two materials can be used as additional materials to reduce cement use, and also as an alternative to help reduce paper waste and rice husk waste, based on the mix design design that all specimens of specimens other than test objects with BN code use of cement are reduced by 50 kg, so when viewed from the results obtained. Cement that is reduced by 50 kg and replaced with these two

materials in a certain percentage can reduce the Use of cement and increase the strength of the concrete. This is in line with our previous research that the addition of paper ash can make concrete performance better. From the results of this study, it is necessary to do more research several times to get maximum and good results. The waste used in this research can have a significant impact as a waste reduction solution, where the waste from this paper has become a problem in developed and developing countries.

Conclusions

From the analysis of the results and discussion, it can be concluded as follows:

Rice husk ash has a dominant chemical content of SiO_2 between 60-80% while chemical ash waste paper containing CaO is more dominant at 92.70%.

- Paper waste ash has a chemical structure similar to PCC (Portland Composite Cement) cement in which the chemical content of CaO cement is more dominant.

- The Use of rice husk ash and paper waste ash A2.5 test code besides being able to increase the strength of concrete, it can also be as a substitute for cement as much as 50 kg per m^3 .

- The Use of mixtures with specimens of specimens A2.5 and A7.5 is best used as material to reduce a portion of cement.

- The Use of both materials in a ratio of 25% : 7.5% or vice versa, can be used as a mixture as an ingredient to reduce the Use of cement.

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