International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878, Volume-8 Issue-3, September 2019

Manufacture of Concrete with Artificial Sand from Rice Husk Waste

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Abstract*: The high level of rice production in Indonesia creates a large amount of waste material as the husks are removed from the edible portion of the rice grains. Grain milling plants—located in almost every region of Indonesia—cause environmental pollution from the incineration of the unused husks. This study investigated the viability of reducing pollution by making effective use of the husks. Our goal was to determine the suitability of rice husk charcoal as a substitute for sand in the manufacturing of concrete. Testing included the weight of both solid and loose components, absorption, and strength. Rice husk was burned to form the charcoal. Cube-shaped concrete test objects were prepared with a size of 15cm x 15cm (up to 15 pieces) with a predicted compressive strength of 25 MPa. The mix design used Indonesian standard SNI 03-2834-2000. Our overall conclusion was positive. We obtained the following test results for the charcoal: weight of 0.581, density of solid contents 258.21 kg/m³, density of the loose contents 247.37 kg/m³, and absorption of 0.51. The compressive strength test of the concrete at 28 days yielded a strong press of 21.7 MPa; at 56 days this was 27.4 MPa; and at 90 days, 31.8 MPa. The Rat content was 2.150 kg/m³ when tested at 56 days and 90 days. Compressive concrete strength exceeded the projected value of 25 MPa, achieving a range of 27.4–31.8 MPa. The rice husk charcoal could be used as an effective substitute for sand and caused heavy concrete to become lighter.

***Keywords* : Charcoal husk, sand, artificial sand concrete.**

I. INTRODUCTION

Rice is the main staple of Indonesia, where a population of more than 200 million people creates a huge demand for the product. For the year 2017, sources from [1] the Indonesian Ministry of Agriculture recorded production of 81.3 million tons of rice. Of this, the grain weight consisted of 10% chaff (husks, hulls), 2% bran (the brown layer of whole brown rice), and 88% white rice. East Kalimantan alone, according to data from BPS in 2015 [2], recorded rice production of 408,782 tons. Rice husk is the outer, protective shell of rice grains. The greater the amount of rice production, the greater the potential for husk waste. With the huge demand for rice in Indonesia, there are many grain processing plants spread throughout the region, each contributing to a large impact on the environment. Many of the by-products of rice milling accumulate unused. When rice husks are incinerated to dispose of the waste piles, air pollutants are emitted from the combustion, affecting human health in the local area, polluting the environment, and affecting the climate. The effects of waste disposal on air quality and on the environment are shown in Figure 1.

Fig. 1. Rice husk waste that pollutes the environment

Numerous efforts have been made to minimize agricultural waste by using unwanted by-products for other purposes. A small percentage of rice husk has been used in the creation of plant growing media and plant fertilizers. In the manufacturing of concrete [3], as tested in this study, ash from rice husks has also been substituted for sand because of its large silica content.

In our study, rice husk was made into charcoal and was then used as a substitute for sand in the making of concrete. According to, rice husk charcoal has a partial chemical content of SiO2 (silica), ranging from 62.5%–97.6% [4]. For the full composition, see Figure 2.

Fe2O3	0,1 - 2,54
SiO2	62,5 - 97,6
CaO	0,1 – 1,31
MgO	0,01 – 1,31
Na2O	0,01 – 1,58
P2O5	0,01 – 2,69
SiO3	0,1 – 1,23
Carbon	2,71 – 6,42

Fig. 2. Chemical content of chaff charcoal [4].

Manuscript published on 30 September 2019
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Some studies have demonstrated that rice husk ash can add strength to concrete. High-performance concrete that uses both rice husk and fly ash (fine particulates from burning coal), was produced in one study conducted by [5] and provided an additional average compression strength of 2 MPa. Research on using wood in a concrete mixture has also been conducted [6]. Study Utilization of Bentonite in Concrete: A Review, initial & final setting times was observed the bentonite collected from any source. Higher C S of cement mortar were noticed by using 20% of bentonite (heated at 1500 for 3 hours [7], Another project performed [8], study Strength and Durability Studies of RCA based Binary Blended Concrete [9], under the title A Study on High Performance Fine-Grained Concrete Containing Rice Husk Ash used charcoal as a smooth aggregate to make fine-grained concrete with high-performance strength. In that study, the addition of 10% husk charcoal produced a concrete compression strength of 62.3 MPa at the age of 28 days.

The use of husk charcoal has also been used as a substitute for sand to make lightweight concrete [10]. We set out to determine what strength of concrete could be obtained by using rice husk charcoal as a substitute for sand. Our test objects were cubes with a size of 15 cm x 15 cm (up to 15 pieces) with a mix design that used the Indonesian national standard SNI 03-2834-2000 [11]. We predicted a firm press of 25 MPa at the age of 28 days. We tested at 7, 14, 28, 56, and 90 days.

II. MATERIALS AND METHOD

A. The Paper Should Have The Following Structure

All stages completed in this research are shown in the flow chart below in Figure 3.

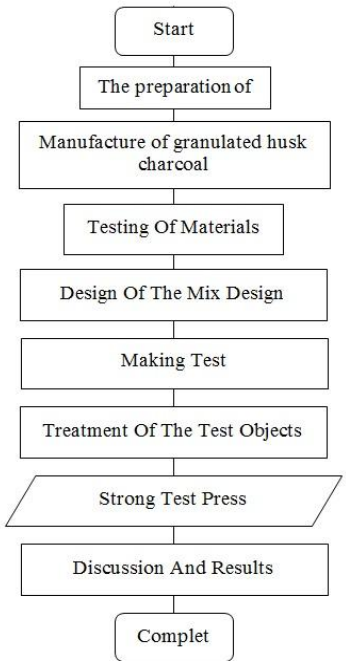

Fig. 3. Flow chart of this research study

B. Rice Husk

For the manual preparation of husk charcoal, the husk was stacked in the shape of a small hill, and then a hole was created in the center at the apex. Next, the counter input wire of the input, and paper was added to the rice husk and burned, as shown in Figure 4.

Fig. 4. The process of making charcoal husk

The burning process that created the charcoal husk was allowed to proceed until everything was blackened. At that point, the pile of charcoal husk was immediately flattened, so that the husk charcoal did not disintegrate into loose ashes. The result is shown in Figure 5.

Fig. 5. Husk charcoal has been

C. Coarse Aggregate

The rough aggregate that we used in making our concrete test objects used broken stone with a maximum diameter of 20 mm. The stone was purchased from PT. Borneo Material. Testing on the stone included the weight, absorption, gradation, mud content, and the original source, using test methods based on the [12] Indonesian national.

D. Cement

The cement used in this study was packaged in 50 kg bags and was a Pozzolan cement composite with the brand name Tonasa. Pozzolan composite cement is a hydraulic binding material. Typically, it is formed from a mix of Portland cement powder and one or more additional inorganic powders. These inorganic materials might include granulated blast furnace slag, pozzolans, silicate compounds, limestones, and others, with a total content of inorganic material ranging from 6%–35% of the total mass of the Portland composite cement. Pozzolan composite cement is commonly used for general construction, such as in concrete work, brick pairs, gutters, roads, walls, and in the manufacturing of special building elements such as precast concrete, preset concrete, concrete panels, concrete brick (paving block), and the like. [13].

E. Water

Water used taken from water laboratory of material testing materials and materials of Civil Engineering Study program Faculty of Science and Technology of Muhammadiyah East Kalimantan University.

F. The Test Objek

Cube-shaped, test objects with a size of 15 cm x 15 cm are made as many as 15 pieces and in the test is at 7, 14, 28, 56, and 90 days as many as 3 pieces. Treatment of Test objects, test objects must be stored in temperatures between 16° to 27° C and in humid environments for 48 hours, must be protected from direct sunlight or tools that emit heat, test objects removed from the mold and given care Standard, if the test item will not be transported for 48 hours, the mold must be removed within 24 hour's ± 8 hours and given the standard maintenance till of carriage [14]

III. RESULT AND DISCUSSION

A. Testing The Husk Charcoal

Charcoal husk test results include dry bulk specific gravity (Sd), heavy precipitation type saturated surface dry (Ss), artificial gravity (Sa), water absorption (Sw), solid contents and weight loss [12]. Charcoal chaff test result as in Table 1.

Table. 1. Physical properties Husk Charcoal

Testing	Test results
Dry Bulk Specific Gravity (Sd)	0.581
Heavy precipitation type saturated surface dry (Ss)	0.878
Artificial gravity (Sa)	0.827
Water absorption (Sw)	0.510
The weight of the solid content	258,21
Lose weight	247,37

B. Coarse Aggregates Testing

The weight of the solid content and coarse aggregate such as loose on a heavy type of Table 2.

Table. 2. Physical properties of coarse aggregate

Testing	Test results
Dry Bulk Specific Gravity (Sd)	2.530
Heavy precipitation type saturated surface dry (Ss)	2.557
Artificial gravity (Sa)	2.600
Water absorption (Sw)	1.070
The weight of the solid content	1,561.41
Lose weight	1,503.51

Filter analysis using method [12] SNI ASTM C136:2012 Examples of the large-size gross aggregate test-the number of test samples that are aggregated for aggregate with a maximum nominal size of ≥ 20 mm in such a way to prevent test sample reduction, except Using the sample separator and mechanical sieve shearing tools. As an alternative, if the equipment is not available drums, rather than combining and mixing the test sample then reduce the example of the field better to do a sieve analysis with an amount approximately equal to the need Test example so that the total mass corresponds to the requirements.

C. Concrete Compressive Strength

After the test object is ready, The testing procedure can begin to be carried out by undoing the test objects in a centric press machine, running a press machine with the addition of a load of 2 to 4 kg/cm2 per-second, performing the loading until the test object Become crushed. Noted the maximum load occurring during test piece inspection, drawing/documenting the damage form of test objects. Noting the state of the test objects, calculating the strong concrete press, namely the magnitude of the wide unity burden [15]. Calculation of strong press of Test objects is done with the formula (1)

$$\text{Strong press concrete} = \frac{P}{A}\ (\text{kg/cm}^2) \qquad (1)$$

The strong concrete press is calculated based on the magnitude of the broad unity burden, according to the equation where;

P = maximum load (kg)
A = the cross-sectional area of the test objects (cm²)

Conversion of objects test cube to the cylinder using the equation (2)

$$\text{Conversions kg/cm}^2 \text{ to fc '} = \frac{\text{kg/cm}^2}{10} \text{ x } 0.83 \qquad (2)$$

The result of the test weight and robust press concrete see table 3

Table. 3. Compressive Strength

The test object's age (days)	Weight (kg)	Strong Press (MPa)
7	2.189	16,77
14	2.175	19,23
28	2.150	21,7
56	2.148	27,4
90	2.145	31,8

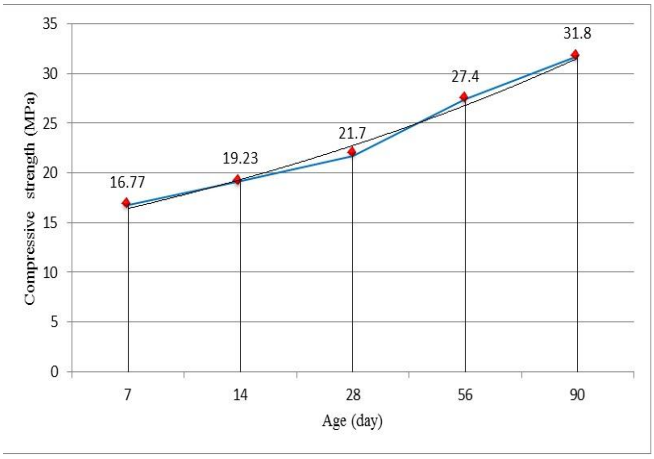

Fig. 6. The development of the compressive strength of husk charcoal sand concrete.

Collapsing patterns of test objects see Figure 7.

Fig. 7. Crack Pattern of Cube

A fractional photo of a test piece after a strong press test see Figure 7.

Fig. 8. Fractions test objects

IV. CONCLUSION

Conclusion of the results of this study, that husk charcoal can be used as a substitute for fine aggregate/sand, a lower type of weight compared with sand, in general, makes the concrete weight slightly lighter compared to concrete in general. Strong press against the concrete at the age of 28 days slightly lower about 3 MPa from Strong press plan 25 MPa, but at the age of 56 and 90 days of concrete strength increases. From the observation of the concrete basic form, the concrete has a smooth pore and the color of the concrete becomes black blackish.

ACKNOWLEDGMENT

Thanks to Professor DR. Bambang Setiaji as Rector of Universitas Muhammadiyah Kalimantan Timur, Ghozali, Ph.D. as Affairs of Academic, Sunarso, SE., MM as Affairs of Students, and Ir. Waluyo Adi Siswanto, M.Eng., Ph.D. as Dean of Faculty Sains and Technology who have guided and support in this research.

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