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Effect of Addition of Rice Husk Charcoal on Concrete Compressive Strength

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Abstract*: Along with the advancement of time, technology in the field of building construction, especially concrete manufacturing, is also experiencing very rapid development, almost every aspect of human life is always associated with concrete. The use of added materials has been done in the process of concrete admixture. Based on this, this study aimed to determine the increase in optimal compressive strength of concrete with additional material of husk charcoal and compressive strength of the plan at 28 days is 20 MPa. In this study using the percentage variation of husk charcoal 0 %, 2 %, 4 %, and 6 % by weight of cement. The analytical review of this research is the compressive strength, with concrete cylindrical specimens having a diameter of 15 cm and a height of 30 cm. The concrete mix planning method uses the Indonesian National Standard (SNI) method. The material for this experiment is rice husk which is made into charcoal by manual process. After testing and research, the results show that the use of rice husk charcoal results in reduced workability because the absorption capacity of rice husk is quite high, and the strength of concrete with the addition of husk charcoal by 2 %, 4 %, and 6 % concrete increases its strength from compressive strength concrete plans of 20 MPa. Concrete compressive strength with a mixture of 2% husk charcoal produces compressive strength of 24, 3 MPa, there is an increase of 4, 3 MPa with the addition of husk charcoal by 2 %.

***Keywords:* Charcoal, Concrete, Admixture, Additive.**

I. INTRODUCTION

For certain purposes sometimes the concrete mixture is still added ingredients in the form of chemical additives (chemical additives) and minerals / additional materials. These additional chemicals are usually in the form of powder or liquid which directly affects the condition of the concrete mixture. While additional minerals / materials in the form of aggregates that have certain characteristics. The addition of chemical substances or minerals is expected to change the performance and properties of concrete mixtures in accordance with the desired conditions and objectives, and can also be used as a substitute for some of the main materials making up concrete. The standard for the provision of concrete additives has also been regulated in Indonesian national standards (SNI) regarding the Specifications of Concrete Additives in Concrete.

The added material for concrete according to SNI [1] is:

1) Additional material is a material in the form of powder or liquid, which is added to the concrete mixture during stirring in a certain amount to change some of its properties;
2) Type A additive is an additive used to reduce the amount of mixed water to produce concrete in accordance with the specified consistency;
3) Type B additives are additives used to slow down the binding time of concrete;
4) Type C additive is an additive used to speed up the binding time and increase the initial strength of the concrete;
5) Type D additive is an additive used to reduce the mixture to produce concrete in accordance with the specified consistency and also to slow down the binding time of the concrete;
6) type E additives are additives used to reduce the amount of mixed water to produce concrete in accordance with the consistency that has been applied and also to speed up the bonding time and increase the initial strength of the concrete;
7) Type F additive is an additive used to reduce the amount of mixed water by 12% or more, to produce concrete in accordance with the consistency that has been applied;
8) Type G additives are additives used to reduce the amount of mixed water by 12% or more, to produce concrete in accordance with a predetermined consistency and also to slow down the binding time of the concrete;
9) Comparative Concrete is concrete with the same proportion of mixture without using additional materials.

Concrete one of the construction materials is currently experiencing very rapid progress. This is inseparable from the demands and needs of the world community on increasingly advanced infrastructure. Concrete is one of the choices as a basic material for structure in building construction. In general, concrete is composed of cement, fine aggregate, coarse aggregate, and water. But along with the development of science and technology, the composition of concrete materials has also changed.

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Rice husk is the outer shell of grain which contains rice, rice is the staple food of the people of Indonesia and some Asian countries so that in Asian countries it is very easy to find rice husk. Indonesia is one of the countries with a population of over 200 people whose main food is rice so that in Indonesia rice husks are found and become one of the potential pollutions of the environment.

In this study conducted an experiment in making concrete by adding rice husk charcoal as much as 0%, 2%, 4%, and 6% of the weight of cement used, the purpose is as an additional material for making concrete, what you want to know in this study is the effect of compressive strength concrete when added with rice husk charcoal.

The more advanced the manufacture of concrete, the more added ingredients and substitutes for making concrete, such as the use of silica fume to make concrete performance better, the use of fly ash, rice husks, etc., research that uses silica fume as a partial replacement of cement with a certain percentage adds strength concrete [2], research into silica fume as an added material for concrete mixes [3]. Research on the use of fly ash Effect of fly ash additives on concrete properties [4] Study of the Properties of Fly Ash Concrete Composites Based on Various Chemical Mixtures [5], making lightweight concrete using waste from ironwood and husk charcoal to produce lightweight concrete has been able to substitute for coarse aggregate and fine aggregate [6].

Chemical content contained in rice husk contains a lot of Sio2 (silica) [7,8], as we know that cement, in general, contains silica, the chemical content of rice husk can be seen in Figure 1.

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. 1. The chemical content of the husk charcoal [8]

II. METHOD

The research includes the manufacture of husk charcoal, material inspection and testing, manufacture of test specimens, concrete treatments and tests conducted at the Concrete Technology Laboratory, Faculty of Science and Technology, Department of Civil Engineering, Universitas Muhammadiyah Kalimantan Timur.

A. Material

The materials used in this study include coarse aggregates, fine aggregates, cement, water, and rice husks.

B. Making husk charcoal

Making husk charcoal is done manually, rice husk is stacked to resemble a small mountain and then the middle is perforated and given a window counter, then put paper into the window of the counter window then burned, burning takes 5 hours with an average temperature of 200 ° - 300 °, after blacking the husk immediately flatten the rice husk to avoid the charcoal from turning to ash. The manufacturing process sees figure 2 - 3.

Fig. 2. The process of making charcoal from rice husks

Fig. 3. Rice husk that has become charcoal

C. Making husk charcoal

Testing of coarse aggregate, fine aggregate, and husk charcoal includes specific gravity; fill weight [9], gradation [10] air content [11], and mud content [12].

D. Mix Design

Mix design used in accordance with the provisions of the Indonesian national standard (SNI) [13], from the conclusions of the mix design, several chaff charcoal presentations were added, the need for husk charcoal was calculated from the weight of cement.

E. Slump Test

The slump test is carried out to find out the thickness of the concrete mortar using tool 7. Cone Abram's and corners of steel rods to measure the value of the slump, by inserting fresh concrete into Abram's cone for three layers, each layer is stabbed for 25 times, then measured collapse height [14] Slump testing equipment see figure 4.

Fig. 4. Slump test equipment

F. Test Objects

The cylindrical specimens with a diameter of 15 cm and a height of 30 cm, fresh concrete were inserted into the cylindrical mold of the test specimens as many as three layers, each layer was stabbed 25 times and vibrated using a rubber hammer [15]. The shape of the test object sees figure 4.

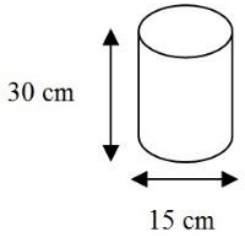

Fig. 5. Plan a test object that will be created

G. Compressive Strength Test

The strength of a material is defined as the material ability to withstand loading or mechanical forces until failure occurs. Mortar compressive strength value is obtained through standard testing procedures, using a testing machine by providing the multilevel compressive load with the speed at which a certain load increases until the object is destroyed. Compression strength is one of the main performances of concrete or mortar. Compressive strength is the ability of concrete to accept the compressive force of broad unity.

Test specimens are carried out at the age of 7 days, 14 days, and 28 days using a compressive strength testing machine, before testing the specimen is weighed and capping using sulfur is done on the upper surface. Testing using procedures and calculation methods [16].

Calculation of compressive strength using equations (1), and (2).

$$f_{cm} = \frac{4000 P_{max}}{\pi D^2} \quad (1)$$

Inch-pund unit:

$$f_{cm} = \frac{4 P_{max}}{\pi D^2} \quad (2)$$

Where:
fcm = compressive strength, MPa (psi),
Pmax = maximum load, kN (lbf), and
D = Average measured diameter, mm (in)

III. DISCUSSION AND RESULTS

In this chapter discusses, analyzes, and calculates the results of research that has been done. The results of the discussion, calculation, and analysis will be described below.

A. Testing Results Material

Table- : I Testing of materials

Testing	Husk charcoal	Fine aggregate	Coarse aggregate
Dry Bulk Specific Gravity (Sd)	0.581	2.473	2.530
Heavy precipitation type saturated surface dry (Ss)	0.878	2.456	2.557
Artificial gravity (Sa)	0.827	2.502	2.600
Water absorption (Sw)	0.510	0.012	1.070
The weight of the solid content	258,21	1.631,29	1,561.41
Lose weight	247,37	1.476,61	1,503.51
Fineness Modulus	-	3.16	7.67
Levels of mud	-	0,31	0,98

From the results of material tests in table 1, the specific gravity and weight of the husk charcoal are very light when compared to other materials.

B. Mix Design

Making the mixture of test specimens using the method [12], the results of the design of the mix design see table 2.

Table- : II The results of the mix design /m^3

Water (kg)	Cement (kg)	Coarse aggregate (kg)	Fine aggregate (kg)
190	376,6	1.035	654,52

From the results of the mix design above, additional husk charcoal for each additional variation, see table 3.

Table- : III Additional variations of husk charcoal

0 %	2 %	4 %	6 %
0	7,5	15,1	22,6

C. Slump Test

The planned slump is 8 cm - 18 cm and the results of the slump test see table 4.

Table- : IV Slump test results

0 % (cm)	2 % (cm)	4 % (cm)	6 % (cm)
13	10,3	10	8,5

From the results of the slump test as shown in table 4, the greater the additional percentage of the husk charcoal, the higher the slump value obtained. That is caused by the high absorption of charcoal husk to water. Test slump sees figure 5.

Fig. 6. Slump test

D. Making Test Specimens

Making test specimens made as many as 36 pieces of test specimens, namely 0% = 9, 2% = 9, 4% = 9, and 6% = 9. Tests carried out at the age of concrete reached 7 days, 14 days and 28 days. Making test specimens see figure 7-8.

Fig. 7. Making test specimens

Fig. 8. Making test specimens

4.5 Curing

Concrete treatment is carried out after the concrete is removed from the mold at least after 24 hours, the concrete that has been removed from the cylindrical mold is inserted into a tub of water, soaking time 2 days before the testing time [15].

4.6 Testing Of Concrete Compressive Strength

Concrete compressive strength testing is carried out at the age of 7 days, 14 days and 28 days. Concrete compressive strength test results see table 5.

Table- : V Compressive strength test

Age (day)	Test Object Code			
	0 %	2 %	4 %	6 %
07	15,3	17,1	16,2	16,1
14	18,2	19,5	18,9	18,4
28	20,6	24,3	21,9	20,7

From the results of the compressive strength test of 0 % in accordance with the planned compressive strength of 20 MPa. Additional husk charcoal with composition 2 %, 4 %, and 6 % concrete has an increase in compressive strength above the compressive strength of the plan, the highest compressive strength obtained in concrete with a husk charcoal mixture of 2 % concrete has increased the strength of 4.3 MPa at the age of 28.

IV. Discussion

From the results of research that has been carried out the concrete with an additional mixture of husk charcoal as much as 2% of the weight of cement has better strength when compared with normal concrete or concrete with additional husk charcoal by 4%, and 6%. The greater than 2% additional husk charcoal, concrete experiences a decrease in strength, but the strength to additional husk charcoal of 6% concrete is still better than normal concrete. Husk charcoal as an added material has an important role to play in influencing the chemical and mechanical properties of concrete. Judging from the mechanical properties, geometrically the husk charcoal fills cavities between cement materials (grain of cement), and results in pore size distribution. Husk charcoal can be used as an alternative additive such as silica fume which has been widely circulating in the market. When doing a mix design it is necessary to make corrections to the absorption of water in the husk charcoal so that the desired slump can be reached, because the absorption of the husk charcoal water is quite high. The use of rice husk charcoal can function the same as silica fume but when compared silica fume rice husk is easier to obtain in countries where the main food is rice, in terms of the production price of making rice husk is much cheaper and very easy to make, because it does not require high technology and very simple in terms of manufacturing.

V. Conclusion

The results of this study can be concluded several things:

- Husk charcoal has a high absorption ability when compared to sand and content weight 258 kg/m^3.
- Adding the husk charcoal makes the slump higher, the more the husk mixture the higher the slump produced.
- Husk charcoal can be used for added ingredients of concrete mix; husk charcoal can add strength to concrete, especially additional husk charcoal for 2%.

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