EFFECT OF UTILIZING UPROCESSED RICE HUSK ASH ON WORKABILITY AND WATER ABSORPTION OF NORMAL CONCRETE

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Abstract—The use of partial replacements or by – products as complementary pozzolanic materials was mostly induced by enforcement of air pollution control in cement production industry. Rise husk is by- product taken from rice mill process. This paper presents the effect of utilizing unprocessed rice husk ash on workability and water absorption of normal concrete due to various proportion of black and grey unprocessed rice husk ash (RHA). Cement was partially replaced with 20 % RHA by weight of cement. The various proportions of black and grey unprocesed RHA was 0, 25, 50, 75 and 100 %. Tests results indicated that there was negative relationship between 20% replacement of unprocessed RHA and workability properties of fresh concrete and water absorption. The higher amount of superplasticizer and water absorption gain when replacement cement with 20% RHA which mean the durability of those concrete were possibly worse than that of normal concrete. The unexpected results are possibly from usage of uncontrolled moisture content of RHA which can agglomerate RHA.

Keywords: uprocessed rice husk ash; black rice husk ash; workability; water absorption; durability

I. INTRODUCTION

Cement is a very valuable commodity as it can be used to construct structurally sound buildings and infrastructure. However, in many developing countries cement is expensive due to the unavailability of local resources to produce enough cement; therefore some contries has to import it to meet the demand of contruction industries. Rice husk ash (RHA) is a material naturally high in silica and can be used as a supplementary cementitious material. RHA can substitute a portion of Portland cement in concrete and can improve strength and durability of normal concrete [1].

Mehta [2] firstly introduced partially replacement of cement with RHA by studying possibly affect rice husk burning process and enhancement the final product. Then, there are a lot of reseach related usage of RHA on concrete. However, there is a limitation information on utilizing unprocessed black RHA on normal concrete. Nowdays, there is a lot of industries utilize rice husk for fuel in boiler to generate electricity. The black color on RHA is due to unfully combustion in rice husk. The black RHA mostly used as fertilizer and mostly rejected in usage of concrete. The high content of carbon in black RHA is one of the reasons. For normal RHA, there are a lot of researches that supported utilizing RHA could improve the mechanical and durability properties of concrete. The normal RHA have a high silica content and amorph silica which is higly reactive. Mahmud [3] et al. in their study indicated that higher percentages of RHA replacement lead to decrease in the compressive strength. However, 10% replacement of cement with RHA attained the targeted compressive strength addition of RHA instead of cement not only improve compressive strength, but also durability representations can be observed in normal concretes. Mahmud and Bahri [4] reported usage of 20% RHA on normal and high sength concrere improve mechanical and durability properties. Mahmud [5] also reported usage of 20% fine black RHA on normal concrete improve strength and durability of normal concrete but utilizing course one reduce strength and durability.

This paper presents the ultizing variation proportion of unprocesed black and grey RHA for 20% cement repacement on normal concrete. The effect of this replacment on workability and water absrption will be shown.

II. METHODOLOGY

A. Materials

Type I Ordinary Portland cement (OPC) used was a local production, Andalas cement, and conformed to ASTM (CEM 42.5). Its average particle size was 12,5 µm. Combination proportion of two type unprocesed ashes, black RHA and normal RHA were prepared as partial cement replacement. The unprocesed black RHA denoted as BRHA (Fig. 1 (a)) and unprocesed normal RHA denoted as NRHA was received from a rice mill in Punteut, North Aceh district. The black color in ash are due to the combustion rice husk was below 400°C and the organic matter like cellulose, lignin etc. was unfully burn and left it into carbon [6]. Table 1 show the chemical properties of OPC, BRHA and NRHA. The average particle size of the BRHA and NRHA was 195 µm and 165 µm, respectively. Based on ASTM C 618 unprocesed RHA can be classified as pozzolanic material, due to its silica content greater than 65% and LoI content lower than 12%.

(a) (b)

Figure 1. (a) Unprocessed NRHA and (b) Unprocessed BRHA

TABLE 1.

Tabel 1
Chemical Properties Of Opc, Brha And Nrha

Chemical composition (%)	OPC	BRHA	NRHA
Magnesium oxide (MgO)	2.06	5.96	0.81
Aluminum oxide (Al_2O_3)	5.60	3.26	0.25
Silicon dioxide (SiO_2)	21.28	63.17	85.76
Sulfate (SO_3)	2.14	1.14	0.31
Calcium oxide (CaO)	64.64	7.78	0.74
Iron oxide (Fe_2O_3)	3.38	0.05	1.15
Loss on Ignition (LOI)	0.60	12.80	4.05

Fine and coarse aggregates used were river sand and crushed river gravel with a maximum grain size of 4.75 mm and 19 mm. The specific gravity of the fine and coarse aggregate was 2.84 and 2.66, respectively

B. Mix proportions of concrete mixes

Table 2 shows the proportions of ash for BRHA and NRHA in normal concrete. The control concrete was designed to achieve a compressive strength of 45 MPa at 28 days based on the BRE mix design method [7]. Slump values for all the mixes were designed in the range of 100-110 mm slump. The mixtures contained constant water/binder (w/b) ratio of 0.46 and the total binder content of 457 kg/m^3. The percentage of cement replacement by ash adopted was 20% [11]. MRHA-20 is the mix proportion ID for mixture containing 20% NRHA and 0% BRHA.

Table 2
Proportions Of Cement And Rha

Mix ID	OPC (%)	NRHA (%)	BRHA (%)
Control	100	0	0
MRHA-20	80	20	0
MRHA-15	80	15	5
MRHA-10	80	10	10
MRHA-5	80	5	15
MRHA-0	80	0	20

C. Experimental procedures

The workability of fresh concretes was measured using a slump test based on SNI 03-1972-90. After placement, the specimens were covered with polyethylene sheet to avoid water evaporation. Concrete cubes of 100 x 100 x 100 mm were casted in wood molds. Molds of concrete were dismantled after 24 hours and specimens were placed in a water curing tank. The water absorption was conducted as suggested by Safiuddin and Hearn [8]. The following equation [Eq. (1)] was used to calculate the water absorption of concrete:

$$water\ absorption = \frac{W_b - W_d}{W_d} \times 100\ \% \quad (1)$$

Where, W_b = the saturated specimen in air, W_d = Oven-dry mass of the specimen in air.

III. RESULT AND DISCUSSION

A. Workability of fresh concrete

Figure 2 shows the amount of dosage of superplasticizer used in each batch mix proportion. In the case of control concrete, it did not require any amount of superplasticizer since its w/b ratio was greater than 0.42. When w/c ratio of OPC concrete is 0.42, all the pores within the system are completely filled with water throughout the hydration reaction [9].

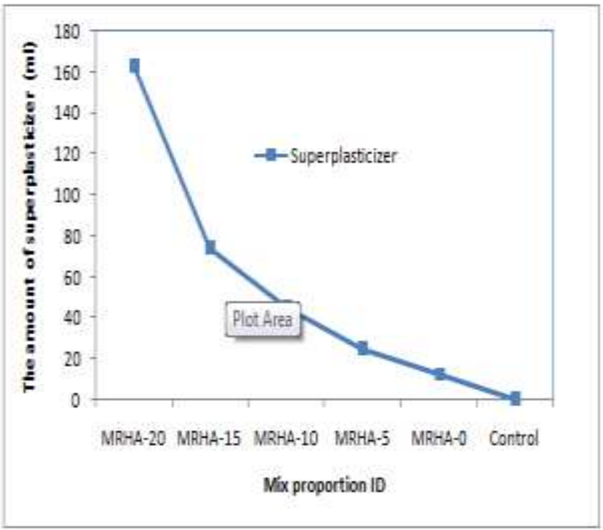

Figure 2. Relationship between mix proportion of RHA and the amount of superplasticizer needed for similar workability

The workability of a concrete mix is provided by the paste which fills the voids between aggregates. The paste acts as a lubricant that reduces internal friction between aggregates while increasing workability [10]. However, fresh RHA concrete needed a certain amount of superplasticizer to achieve similar workability of fresh control concrete. As it can be seen in Figure 2, MRHA-20 has higher surface areas so that it needs more water to cover the surface. Therefore, the available mixing water was reduced and it affected the workability of fresh MRHA concrete. Thus, only mixtures containing RHA required additional amount of superplasticizer to achieve the targeted slump value. The MRHA-20 needed 7 times extra amount of superplasticizer than that of the MRHA-0 mix. However, The MRHA-15 only needed 4 times extra amout of superplasticizer than that of MRHA-0 mix. It shows that black RHA affect the need of superplasticizer and it shows that the amount of superplasticizer was absorpted by NRHA in their porous. Nepomuceno et al. [11] reported that incorporating RHA in concrete mixtures reduced the slump value of fresh concrete and increase the amount of super plasticizer to get similar slump value to that of fresh control concrete. It should be noted that it is very important in RHA concrete production to achieve good workability to ensure appropriate dispersion of the fine particles and proper migration of them in concrete [12].

B. Water absoption of normal concrete

Figure 3 shows the water absoption of varios ratios of BRHA and NRHA in normal concrete. The results was unexpected as the water absorption of RHA concrete was higher than that of normal concrete. Most reserach revealed that usage either RHA or BRHA could improve the porosity of concrete. RHA react with CaOH of hydration product forms another calsium silicate hydrate (CSH) which reduce pores and denser concretre [13]. In this study, even normal RHA could not improve the porosity of RHA concrete which most research reported the improvement in porosity. It could be unprocesed RHA failed to react as pozzolanic material and also fail to be filler as average paricle size of cement is 12 µm while average particle size of NRHA is for MRHA-0 mix is 165 µm. The usage of unprocesed BRHA is not suggesed as it was not reactive and fail function as filler as well. The other possibility is the moisture content in NRHA which can cause agglomerate and cement sorrounded NRHA. Later, the agglomerate NRHA was sorrounded by cement hydration wich protect NRHA to react and left it as porous material. As it can be seen in Figure 3, most NRHA concretes have higher water absorption than that of normal concrete. It is a valuable information for concrete industries when utilizing NRHA need to consider the moisture content of NRHA.

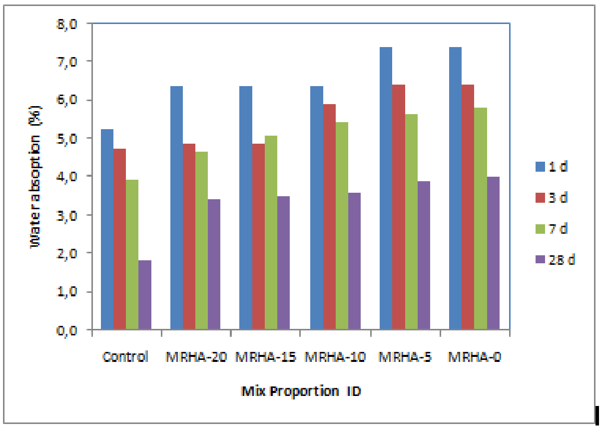

Figure 3. Relationship between mix proportion of RHA and normal concrete with water absorption

IV. CONCLUSIONS

In this study, unprocessed normal and black rice husk ash were applied to normal concrete to check the workability and water absorption of normal concrete. Based on the test results of this study, the following conclusions can be drawn. The unprocessed RHA required more amount of superplaticer than unprocessed black RHA as unprocessed RHA having porous than unprocessed BRHA. Water absorption of unprocessed RHA is lower than unprocessed black RHA but still higher compared than that of normal concrete.Moisture content of unprocessed RHA and BRHA need to consider when utilizing them in concrete.

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