The Compressive Strength and The Absorbtion of The Clay Brick With The Rice Husk Ash and The Palm Oil Fuel Ash

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Abstract

The Clay brick in Bengkulu Province of Indonesia is usually made of the mix of clay and water till plastic enough to be molded. This research try to obtain the sustainable materials for the brick to settle the shrinkage since the clay quarry is limited. This study used rice husk ash (RHA) and palm oil fuel ash (POFA). Each type of ashes were added to the clay mixture in four different ash variations namely 5%, 10%, 15%, and 20% based on the weight of the clay. The production of the bricks were manufactured according to the method at the factory. The result shows that the bricks compressive strengths decline as the ash percentages increase while the absorption increases as the utilization of ash increases. The compressive strength of RHA bricks are better than the POFA bricks. Both of ashes increase the volume of the bricks but the bricks volume of 10% to 20% POFA is larger than the volume of RHA bricks.

Keywords : clay brick weight, clay brick volume, agricultural waste.

Introduction

The clay bricks as the material of the wall are generally used in Bengkulu–Indonesia due to its reasonable price. The brick manufacturing needs only simple skill and tools. The clay is available in the factory area or can be bought cheaply. Many people take brick manufacturing to be their occupations for those reasons. The clay brick is not the expose one. The brick wall is usually covered by the mortar for protecting propose.

The brick in Bengkulu is made of clay and burnt in the kiln. The brick size is smaller than the code and the absorption is in a range of 25,7% till 26,5%.The main problem of the brick manufactured in Bengkulu is the shrinkage. The volume brick shrinkage is about 42% while the weight shrinkage is bigger (Elhusna, *et al.*, 2014). The shrinkage causes the mold size must be enlarged in order to meet the brick size to the code. The utilization of more clay becomes the consequences of using large mold while the clay quarry is limited and unsustainable (Elhusna, *et al.*, 2014).In that case, renewable resources to substitute the clay is needed. Using waste material and renewable resources which is popular as part of "green technology program" (Wahyuni *et al.*, 2014) can become one of the solution to cope with the limitation of the clay. Ramezanianpour *et al*. (2009) report that sustainable development of the cement and concrete industry requires the utilization of industrial and agricultural waste components. Recycling of waste components contribute to the energy savings in cement production and the conservation of natural resources in order to protect the environment.

This article reports the study of agricultural wastes utilization in clay brick. Rice husk ash (RHA) and palm oil fuel ash (POFA) which used in this research are sustainable agriculture wastes. The compressive strength and the absorption as the important performance of brick are reported in this article.

Palm oil and paddy production in Bengkulu Province are increased every year. Palm oil production at 2014 in Bengkulu Province and Indonesia are 798.818 tons and 29.278.189 tons (Directorate General of estate Crops, 2014). Paddy production in Bengkulu Province at year 2014 is 593.194 tons (Statistic of Bengkulu Province, 2015). It is known that at least 20% husk or 4% husk ash becomes the waste of the paddy production. In that case, 118.639 tons rice husk or 23.728 tons rice husk ash is available in Bengkulu Province in year 2014 and the waste is increased every year.

Rice husk ash

Rice husk ash (RHA) is the combustion residue of the rice husk which is the shell produced during the dehusking operation of paddy rice. Each ton paddy rice produces about 200kgs of husk which on combustion, yield approximately 40kg ash (Mehta in Xu, *et al*., 2016) or about 20% of its weight after the incineration (Anwar, *et al.* in Givi *et al*., 2010). When this husk is burnt in the boilers, about 25% of RHA is generated (Kumar, *et al.*, 2012). Rice husk ash are greatly affected by the burning conditions. When the combustion is incomplete, large amount of un burnt carbon is found in the ash. When the combustion is completed, grey to whitish ash is obtained (Mohan *et al.*, 2012).

The addition of 20% RHA decreased the crushing strength of the bricks to be around 63% of the strength of the control bricks. The water absorption of the bricks increase as a slow rate with the increase up to 20% of RHA (Hossain, *et al.*, 2011). The optimum proportion for bricks was observed as 30% RHA and 70% clay as the bricks exhibited high compressive strength and low brick weight. As the percentage of RHA increased, the water absorption of RHA–clay bricks was also increased (Mohan, *et al.*, 2012). The brick with RHA will expand and cause distortion of the bricks when they are burnt in the kiln, but It is found that there was no definite relationship between the percentage of RHA and the change of the volume (Hossain, *et al.*, 2011).

Palm oil fuel ash

Oil palm fruit production contains 43–45% mill residues in the form of empty fruit bunches (EFB), mesocarp fruit fibers (MF), and palm kernel shells (PKS). MF and PKS wastes are used extensively as fuel for steam production in palm–oil mills in their own low pressure boilers (Abdullah and Sulaiman, 2013). Mesocarp fibers and PKS are ready use as boiler feed (UNEP, 2012) and produce ash called as palm oil fuel ash (POFA). Oil palm waste is a reliable resource because of its availability, continuity and capacity for renewable energy solution (Abdullah and Sulaiman, 2013)

Palm oil fuel ash (POFA) decreased the manufactured bricks compressive strength but increased their dry shrinkage and initial rate of suction (IRS) as a result of increased porosity value. Nonetheless, the incorporations of the ash into a clay brick has improved its thermal conductivity properties and energy efficiency during manufacturing. The ash can be considered for producing lightweight fired clay bricks as they could act as pore formers to improve the thermal properties and energy efficiency in brick firing process (Kadir, *et al.*, 2013).

Material and Methods

The main objective of this research is to find out the influence of the utilization of RHA and POFA to the compressive strength and the absorption of the clay bricks in Bengkulu–Indonesia. The brick volume is also reported since the shrinkage of the local bricks is large as mentioned above. The process of the brick specimens manufacturing is held in the brick factory.

Four different variations of each type of the ashes were added to the clay mixture namely 5%, 10%, 15%, and 20% based on the weight of the clay. RHA and POFA used were taken from the mills. The ashes were dried under the sun to remove the moisture content. Both of the ashes were screened before used. The specific gravity of RHA is bigger than POFA. The physical properties of the clay and the ashes are given in Table 1. The bricks manufacturing process since mixing the materials, molding, drying and burning took about 21 days. The size of the bricks were recorded in order to find out the volume. The water absorption and the compressive strength were tested in the laboratory in accordance to ASTM, C67–07.

The brick absorption is the difference between the soak weight and the dry weight. The bricks were soaked in the water for 24 hours. The brick weight before and after the soak process are recorded. The compressive strength specimens were the bricks covered with mortar at the top and the bottom. The mortar was made of the proportion of cement and sand equal to 1and 3 based on the volume. The brick test at the age of 7 days of mortar shows that every first crack occurred at the brick. The compressive strength value was defined as the value of the first crack that occurred at the brick. The absorption, the compressive strength and the volume that reported are the normalized ones to the control bricks. The control bricks are the bricks without the ashes.

Table 1. Physical properties of clay, rice husk ash and palm oil fuel ash

Properties	Clay	Rice husk ash	Palm oil fuel ash
Specific gravity (kg/cm^3)	2,71	1,72	1,42

Results and Discussion

The compressive strength and the absorption are important performance of the brick. Low compressive strength brick can only be used as filler wall. While the high absorption of the brick is the mainly reason to protect the brick wall from the water. Covering the brick wall with mortar can be a way to protect the brick from absorbing water.

Both of the ash types increase the absorption of the bricks (Figure 1) but the trends are different. RHA causes the bricks absorption increase in slow rate and become the stable value when RHA is more than 15% while POFA causes the bricks absorption increases in higher rate and keep increasing till 20% POFA. The absorption of the 5% RHA brick is higher than the POFA one while RHA brick absorption is less than PAFO one when the bricks contain more ash.

RHA and POFA in clay bricks reduce the compressive strength (Figure 2). The compressive strength of RHA bricks are better than the POFA bricks. The strength of RHA bricks trend is better than the POFA's trend but both of the ashes decrease the strength as the ash in bricks increases.

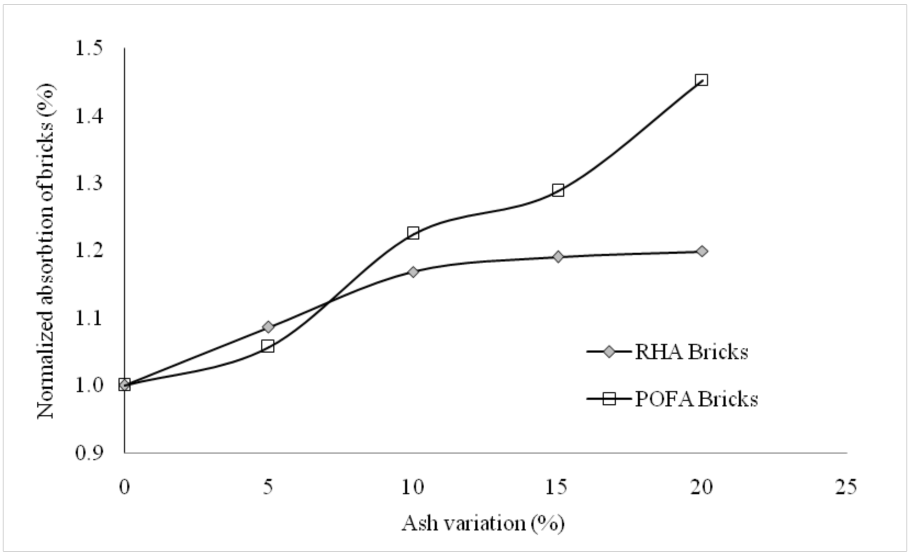

Figure 1. The absorption of RHA and POFA bricks.

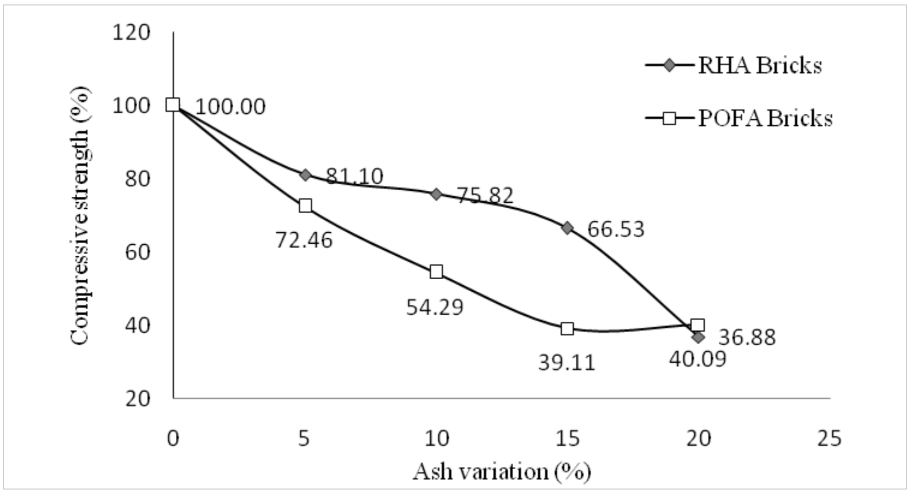

Figure 2. The compressive strength of RHA and POFA bricks.

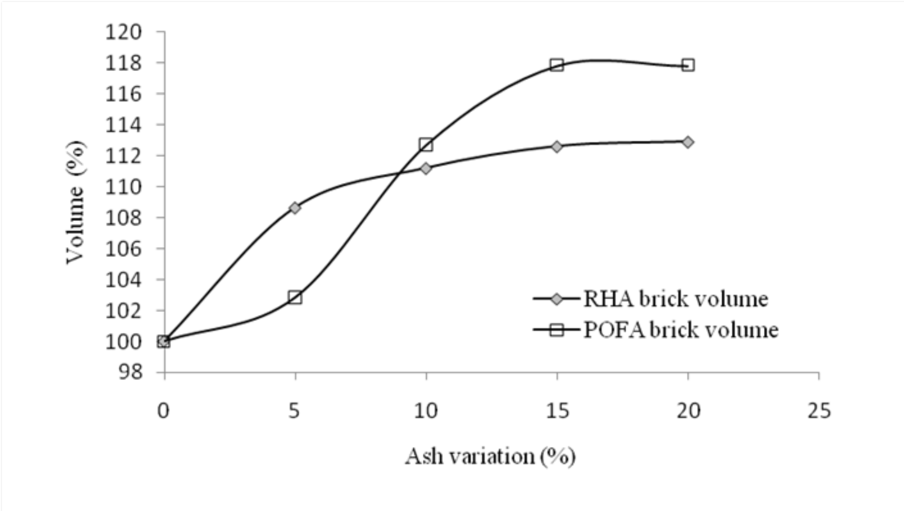

Figure 3. The volume of RHA and POFA bricks.

RHA and POFA expand the brick volume in different trends (Figure 3). The RHA brick volume keeps expanding but the trend is in slow rate when the RHA is more than 10%. The volume (Figure 3) and the absorption (Figure 1) diagrams of RHA bricks show similar trends. The POFA bricks volume is also comparable to the POFA brick absorption but the volume trend is started decreasing at 20% ash while the absorption is still increased. The bricks volume of 10% to 20% POFA is larger than the volume of RHA bricks while the volume of the brick at 5% RHA is larger than the other. The utilization of RHA and POFA in clay bricks expand the volume and can decrease the utilization of the clay

Conclusions

The compressive strength of RHA bricks is better than the POFA bricks but both of the ashes decrease the brick strength as the ash increased. The utilization of RHA and POFA in clay brick affect the absorption and the volume almost in the same way. The absorption and the volume increase as the utilization of ashes increased. RHA bricks are less porous since the volume trend is lower than the trend of POFA bricks. Both of the ashes increase the volume of the bricks. further research is needed in order to maintain the brick performance so that RHA and POFA can be used as one of the material in clay brick production.

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