Performance of composite sand cement brick containing paddy husk

M H Ahmad, M N Arib, F Mat and U Kassim
School of Mechatronic Engineering, Universiti Malaysia Perlis, Pauh Putra Campus 02600 Arau, Perlis, Malaysia.

Corresponding author: *mnarib@unimap.edu.my

Abstract. This research concentrates on the performance of composite sand cement brick containing paddy husk also known as rice husk. The main objective of this research is to determine the mechanical properties possess by the composite sand cement brick containing rice husk, such as water absorption and compressive strength. The bricks were designed to contain 0-4% of RH. The brick specimens were naturally sun dried and be cured for 28-days in protected space. The percentage of water absorbed increases from controlled specimen to 1% of RH and slightly decreases at 2% of RH. The value then increases significantly at 3% and 4% of RH. The optimum amount of the RH percentage in this research would be at 2% correspond to the water absorption of specimens. For the compressive strength, the results show steep decrease from controlled specimen to 1% of RH and began to increase from 2% till 3% of RH and significantly decrease again. The optimum amount of the RH percentage in this research would be at 3% of RH correspond to the compressive strength of specimens. Thus implies that the addition of rice husk into the brick causing the brick to have lower density, subsequently increase water absorption and decrease the compressive strength of the brick.

1. Introduction
The oldest brick manufactured in ancient method by a process known as soft mud process where the condition of the brick was relatively moist and press into the moulds by hand [1]. Currently making the clay brick as the oldest and most durable construction technique invented by human [2]. The clay brick available in form of burnt or sun dried has been long ago been around in earlier civilization approximately 10 thousand years ago and considered as easy to produce and light weight than natural stone or rubble, easy to fix into shape and function as wall which is durable and strong against fire. Nowadays, all around the world many bricks were used as combination with other masonry material such as stone, roof or floors [2].

Block or brick is considered as very essential for every construction in the industry is generally used and requested exceptionally. While white brick, unfired brick also known as cement brick which is widely uses when constructing and remodel of houses and other small construction in Malaysia because of it handy to procure and not as high as other brick in term of pricing [3]. Currently, world agricultural sector growth are undergoing a very fast pace. However, the active expansion of the agro-based industry is accompanied by wastes. By salvaging fibers from predisposed leaves and husk to be integrate in masonry material can helps reducing wasteful landfill and harmful open incineration[4].

This research aims to determine the strength of the brick with respect to compressive strength and the water absorbed as the brick containing reinforcing material compared to normal brick.
2. Methodology

The mixtures were moulded into a mould with the size of 212 mm in length, 90 mm in width and 63 mm in depth. The mix design ratio of sand cement brick used is 1:4 of sand cement. The process of moulding the brick started after the all materials were mixed including water, then placing the mixture into the mould in 3 layers and been tampered for 25 times for each layer. At 24-hours period the brick specimens were removed from the mould to be labelled according to the mixture proportion and to be cured. The process of fabricating the bricks repeated for remaining bricks proportions. The process of curing takes place for 28 days after the bricks were removed from the mould. There were 15 fabricated specimens for compression test and 5 specimens for water absorption test, respectively.

The objective of the compression and water absorption tests were to define the bricks mechanical properties. For compression test, 3 specimens were prepared according to the percentages of 0%, 1%, 2%, 3% and 4% rice husk with ratio of 1:4 while for the water absorption test, only 1 specimen prepared for each percentage of rice husk. The test conducted on the specimen was in duration of 28 days curing. The procedure for testing the compression strength test was consistent with MS EN 12390-3:2012 “Testing Hardened Concrete”. The procedure for water absorption test followed BS 3921:1985.

3. Result and discussion

20 specimens were used to conduct the experimental test and elaborated from tabulated data and graphical form.

3.1. Water Absorption

This test was conducted to determine the permeability of the specimens. The percentage of water absorbed was calculated based on the mass weighed before and after the immersion in the water for 72-hours. The quantity of water absorbed by the specimens or the absorptivity of the specimens was determined by the water content ratio to the dry mass of the specimens. The amount of water absorbed by the specimens was influenced based on the percentages of rice husk present in the brick because the added rice husk forming the void of volume which the water sinks into. Both amount of water absorbed, and the void volume give effect to density.

From results in Figure 1, it depicted that the water absorption of the specimens containing rice husk increased significantly as the rice husk percentage added for all mixtures. The amounts increased for lowest and highest water absorption of specimen with rice husk mixture were almost 1.89 and 3.14 times the controlled specimen. However, at rice husk percentage of 2% the water absorbed decreased about 1.776% and begin to increase again about 2.169% at rice husk of 3% and eventually absorbing water for the most at 17.901% when the bricks specimen containing 4% of rice husk. The controlled specimen was obviously less permeable compared to other specimen, but among the specimen having a mixture of rice husk the specimen of 2% showed the less permeable as to another specimen. From the results it can be concluded that the present of rice husk in the constituent of brick was greatly affected the water absorption characteristic of a brick.
3.2. Compressive Strength

This test was conducted to determine the strength of the specimen brick to withstand the compression under load with intend to failure. The load applied to the specimen was applied with no shock and increased continually until the failure and the maximum load was recorded. The compressive strength was obtained by dividing the maximum force with cross-sectional area. According to British Standard [5] the bricks should have load carrying capacity of more than 7 N/mm². The results of compressive strength of bricks specimens were depicted in Figure 2. From the figure, it can be seen that the brick specimens containing rice husk were inferior to the controlled brick, as the highest compressive strength of the composite brick specimens was 5.82 MPa which 2.15 times and about 63.2% less than strengths of the controlled brick with 15.802 MPa. Among the brick specimens containing rice husk, the brick with 4% was the lowest in term of strength compared to other specimens. The compressive strength of composite brick began to increase slightly from 1% RH brick with 4.384 MPa to 5.097 MPa of 2% RH brick and continually increased to 5.82 MPa of 3% RH brick which is the highest and from then it began to significantly decrease to 2.555 MPa at 4% RH brick.

The outcome from the experiment was unexpectedly low compared to controlled specimen. It is concluded that with addition of rice husk fiber to replace small amount of fine aggregate of sand of the 28-days cured white brick would lowered the compressive strength of the bricks. Low in compressive strength with presence of rice husk was attributed to the lack of rice husk to strengthen or enhance the cement paste as many large void spaces formed up and did not construct cementation links among the sand particle. In this case, the compressive strength decreased and no improvement in the cementation matrix [6,7,8].

Figure 1. Water absorbed against RH percentage.

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4. Conclusion

In this research, the bricks specimen was fabricated using mould prepared to have the size of the brick available in the industry. The fabrication processes involving preparation of the material according to the mix design ratio, casting the bricks and cured for 28-days to obtain the constant mass. The rice husk used in the research was raw material without any treatment.

In this research, there are two primary objectives to be achieved which one of them was to determine the compressive strength of sand cement brick containing rice husk. The objective was successfully accomplished although the result was unexpectedly low compared to the controlled brick. The highest compressive strength recorded among the brick specimens was 5.82 MPa of 3% RH while the lowest was 2.55 MPa of 4% RH. The compressive strength was very low because of the density, shape, size and distribution of the rice husk in the cementation was coarse and not evenly distributed. Uneven distribution of the rice husk created the lumps of cement and leaves the matrix a void space and porous thus weaken the bricks. As the density decreased the compressive strength also decreased. The compressive strength shows a steep decrease from controlled specimen to 1% of RH and began to increase from 2% till 3% of RH and significantly decrease again. The optimum amount of the RH percentage in this investigation would be at 3% of RH regarding the compressive strength of specimens with RH.

The second objective was to determine water absorption of sand cement brick containing rice husk. The objective was successfully accomplished within the expectation. The highest recorded water absorption among the specimens with rice husk was 17.901% of 4% RH while the lowest was 10.784% of 2% RH. The overall result based on the graph of the water absorption. The percentage of water absorbed began to increase from controlled specimen to 1% of RH and slightly decreases at 2% of RH and increases significantly at 3% and 4% of RH. The water absorption was high because of the permeability of the rice husk and the pore of the brick and their void volume was larger sufficiently to absorb the water. The optimum amount of the RH percentage in this investigation would be at 2% of RH corresponding to the water absorption of specimens with RH.

Figure 2. Average compressive strength against RH percentages.
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