Environmental Assessment of Reed as Filler In Structural Bricks

[1]Kurniati Ornam, [2]Masykur Kimsan

[1,2]Civil Engineering Department
[1,2]Faculty of Engineering
[1]Halu Oleo University, Kendari,Indonesia

***Abstract*—This paper scutinizes environmental effect of reed as filler in structural bricks. In relation with sawdust properties as insulator, reed (*imperatacylindrica*) which is expected to share particular result as sawdust does upon brick's production. Brick's production follows conventional process in home industry, with 1:8 of water-clay ratio. Nine compositions of reed mixed with clay i.e. 9% (type A), 13% (type B), 17% (type C), 20% (type D), 23% (type E), 26% (type F), 29% (type G), 31% (type H) and 33% (type I), it will be evaluated on its dimension, weight, and compressive strength. The result shows that all types adequate with standard**[1]–[5]**, both the physical and mechanical properties. In average, 0,2% of IRR yields subjected result in acquiring compressive strength for 12 MPa in average. Therefore, utilization of this filler for bricks material might contribute to the criteria of green building since 11 of 14 point maximum is potentially provided by this modified green material based on greenship rating tools.**

***IndexTerms*—Reed, filler, brick**

I. INTRODUCTION

Demand for housing hasa positive correlationwith a number of people growth, which presumably increasing each year. This correspondingly generates proliferation of housing's element, both structural and non structural element. Bricks, one of non structural housing element, are regularly utilized for wall since their prices could be relatively afforded in addition with their properties performance in heat transfer. Nevertheless, bricks production in thehome industry had encountered classic drawback where the level of productivity is tends to decrease as a consequence of modest technique of production process. Also, environmental impacts,e.g., flood and erosion might ensue resulted from the excavation of the soil and logging. Hollow brick design reduces approximately 25% of soil [6]. Heat transfer performs acceptably in this model where it spreads more quickly and evenly in brick structures than on theconventional model and hence minimizing the possibility of crack following unloading phase. On the other hand, the use of sawdust as inner burning accelerates burning time twice and it also can reduce the use of firewood for about 50% (ornam et al, 2015).

On that basis, as an organic material that has most similar characteristics to sawdust, reed (Imperata Cylindrical) is then developed to be engineered materials of as a mixture for bricks compotition. Reed is categorized as wild plant and agricultural nuisance plant that grows easily and rapidly in various places, especially in a fertile soil that might reach 1,0 to 2,0 meters of height. Some agricultural experts estimate the total area of reed in Indonesia might reach 200.000 million hectares with the growth rate at 16.000 hectares that regularly continues over time [7]. Several other studies in the development of bricks have been conducted by mixing natural materials i.e. fiber or mixed waste material including corn and coconut [8], lime sand,soil-fly ash [9]. Therefore, as similar organic materials, reed might be used as a mixture of brick and through this study, it is aimed to scrutinize the effect of reed on the bricks as a building material as compared to standard bricks (conventional) from the environmental view.

II. METHODOLOGY

This research was performed in two approaches i.e. laboratory testing and production process in the home industry ward. Before laboratory works, fresh/green reed was first obtained where its height reached ± 1 meter and then dried by direct sunlight until reed color changed to amber. After that, the reed was then severed to the smallest size (± 2 mm), [1] and [5] i.e. 8 : 1. Furthermore, the composition of the soil and reed was also determined where the average weight of soil was 2 kg while the reed varied in 9 (nine) composition i.e. 2: 0,2 (9%); 2: 0,3 (13%); 3: 0,4 (17%); 2: 0,5 (20%); 2: 0,6 (23%); 2: 0,7 (26%); 2: 0,8 (29%); 2: 0,9 (31%); and 2: 1 (33%). Weight measurement of soil and reed was performed by digital measuring scales. Also, soil testing was conducted in the laboratory to determine soil classification by [1] and [5].

Fig. 1. The preparation of reed

Next, the production process was performed in the ward and the laboratory. Clay was mixed with reed and water by the predetermined composition, where 30 pieces of brick for each composition. (Figure 2).Every piece was then carefully treated until the mixture did not stick and was easy to be shaped into the quadrilateral prism mold with 21,5 cm length, 11 cm width, and 5 cm thickness. Once bricks have been fully molded, they were arranged for drying purpose on the outer side of the ward of obtaining direct sunlight for ± two weeks. The dried bricks were then arranged in a rectangular furnace by using firewood as fuel. The furnace is in the form of a pile of bricks on the ground that its depth reaches 50-70 cm from ground level, where the brickwork was made such that there was a hole to insert the firewood, and the burning process took two days.

Fig. 2. The producing of bricks

Fig. 3. Bricks

Table 1. The time comparison between conventional brick and modified brick

Reed content	Burning time (day/hrs)	Percentage of fire wood reduction (%)	Number final brick
Conventional Brick	5/20	100	252/500
9% (Type A)	3/21	63,83	384/500
13% (Type B)	3/18	63,83	397/500
17% (Type C)	3/12	59,57	414/500
20% (Type D)	3/9	57,45	432/500
23% (Type E)	3/5	54,61	452/500
26% (Type F)	2/22	49,65	461/500
29% (Type G)	2/17	46,10	478/500
31% (Type H)	1/23	33,33	482/500
33% (Type I)	1/16	28,37	498/500

III. Result and Discussion

Regarding bricks density, traditional bricks exceed the requirement i.e. 1,60 – 2,00 gr/cm3 (table 2). On the contrary, modified brick density is between 1,60 and 1,84 gr/cm3. The density of bricks is influenced by the composition of the raw materials, mixing process either manual or using a blender, and the duration of drying and burning process. The result indicated that the adding of reed material on brick result the decreasing of brick density.

However, as can be seen on Table 2, conventional brick reaches 8,21 MPa for compressive strength, and classified as third grade based on [1]–[5] standards. On the other hand, in average modified brick shows better performance than conventional brick. The best performance of brick based on the compressive strength is type A or 9% reed.

Table 2: Brick's density of brick modified

Reed Content	Brick Density (gr/cm3)	Compressive Strength (N/mm2)
Conventional brick	2,37	8,21
9% (Type A)	1,68	15
13% (Type B)	1,60	12,4
17% (Type C)	1,73	9
20% (Type D)	1,79	12,25
23% (Type E)	1,84	12,7
26% (Type F)	1,71	10,86
29% (Type G)	1,71	14,5
31% (Type H)	1,64	10,4
33% (Type I)	1,65	11,4

Greenship rating tools evaluation

Among 7 (seven) criteria in greens rating instruments, utilization of reed in basic bricks is merely relatedtoreal sources and cycle criterion. Regarding local housing in surrounding reed plant area, utilization modified bricks as asubstitution for conventional bricks, economically, might reduce production cost by 50%, since 50% reduces the use of firewood in the ward compared to conventional bricks. Regardless the other factors in association with material expenses, 2 points might be afforded from the criterion building and material reuse since those modified bricks are classified as reused material, which in the future, they might reduce total cost to 20% minimum.

IV. Conclusion

Test results indicate that the modified brick with certain composition shows better quality compared with a conventional brick. Modified bricks as building material based on [1]–[4], and [5]. Increasing of density indicates similar distribution after burning due to insulator's properties of reed. Since this modified bricks meets the criteria of strength, in terms of physical and mechanical properties, beside it costs relatively low in production, it provides oppurtunity as prospective support to green building criteria especially for real sources and cycled.

V. Acknowledgment

Enormous thanks to the Islamic Development Bank and Bank Indonesia, which had served financial aid for building material research. The researchers give appreciation for Soil Mechanics Laboratory and Materials and Building Construction Laboratory of Halu Oleo University that has provided support for the testing equipment. Last, Workshed Said Jaya in Punggolaka Village, District PuuwatuKendari city as a place of brick production in the home industry scale.

REFERENCES

[1] ASTM C216-15, "Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale)," West Conshohocken, PA, 2015.

[2] ASTM C652-14, "Standard Specification for Hollow Brick (Hollow Masonry Units Made From Clay or Shale)," West Conshohocken, PA, 2014.

[3] ASTM C67 - 14, "Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile," hods for Sampling and Testing Brick and Structural Clay Tile, ASTM International, West Conshohocken, PA, 2014.

[4] ASTM C62 - 10, "Standard Specification for Building Brick (Solid Masonry Units Made From Clay or Shale)," West Conshohocken, PA, 2010, 2010.

[5] S. N. Indonesia, "Bata Merah Pejal Untuk Pasangan Dinding," SNI 15-2094-2000, 2000.

[6] K. Ornam, M. Kimsan, and E. Cahyono, "Evaluation of Alternative Design of Hollow Brick with Sawdust as Filler for Home-Made Industry," in *Proceeding of 4th International Conference on Energy Systems, Environment, Entrepreneurship and Innovation*, 2015, pp. 373–376.

[7] T. S. Hardono, "Kajian Pemanfaatan Serat Alang-Alang Untuk Pembuatan Bata Ringan Berlobang," *Wahana Tek. Sipil*, Vol. 16, no. 2, 2011.

[8] M. S. Arshad and D. Pawade, "Reuse of Natural Waste Material for Making Light Weight Bricks," *Int. J. Sci. Technol. Res.*, vol. 3, no. 6, 2014.

[9] S. T. Rushad, A. Kumar, S. K. Duggal, and P. K. Mehta, "Experimental Studies on lime-soil-fly ash bricks," *Int. J. Civ. Struct. Eng.*, vol. 1, no. 4, pp. 994–1002, 2011.