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I-SEEC 2012

Proceeding - Science and Engineering (2013) 486–491

Proceeding
Science and Engineering

www.iseec2012.com

Science and Engineering Symposium
4th International Science, Social Science, Engineering and Energy Conference 2012

Effects of Temperature on Mechanical Properties of Bricks

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Abstract

This research aimed to study the effect of sintering temperature on the mechanical properties of bricks, such as density, compressive strength, water absorption, and microstructure. The combination of the combustion temperature varied from 750 °C, 800 °C, 850 °C, 900 °C and 950 °C. The results showed that the combustion temperature at 850 °C gave the best brick properties with 14.3 MPa of compressive strength, 1.79 g/cm^3 of density, 14.4 % of water absorption, and 28.9 % of porosity.

Selection and/or peer-review under responsibility of Faculty of Science and Technology, Kasem Bundit University, Bangkok.

Kerwords: bricks product, rice husk ,ceramics

1. Introduction

The term brick, referred to small units of building material, often was made from fired clay, secured with mortar, a bonding agent comprising of cement, sand and water. A popular material for many years, brick retained heat, withstanded corrosion and resisted fire. All of the bricks in Thailand were made from a combination of clay and rice husk or saw dust. This combination material sintered with furnace for rigidity and strength. The brick was a main material in construction due to its strength, durability, loading ability, compactness and light weight. The brick's utility in construction in Thailand has been used long ago. Most of old constructions could confirm the popularity of brick. The brick was well-known and widespread due to durability and local production, local composition and labour. General properties of brick easily allowed heat transfer and keep the heat inside for long time, which means it had a high heat capacity. The brick was therefore appropriate for construction material. The product of brick in Thailand produced all regions, from cottage industries to large industrial plants. However, a common problem was processing and procedures that occurred in production. For example, the inconsistency ratio of composition and low efficiency of knowledge in raw resources could cause low brick quality. Many researchers had studied the effect of rice husk on the product. The results indicated that the addition of rice husk in composition caused decreased compressive strength and more porosity. We would study the effect of rice husk

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ash in increasing the compressive strength of concrete [1-3] and the effect of rice husk ash to deduct the temperature of whiteware [4]. For this research, we would study the effect of combustion temperature to the mechanical properties of bricks.

2. Experiment procedures

The clay, rich husk ash and rice husk were selected from the Bang Ban district Ayutthaya province. X-rays Fluorescence was used to analyzed chemical compositions. The combination of raw material was clay and 2 percent by weight of rice husk. The product was examined by the Thai Industrial Standard of brick TIS.77-2545 [5]. The experiment properties had compressive resistibility, water absorbency, contractibility and density. The sampling combinations were extruded and sintered by sintered in furnace, as show in Figure 1. All of the samples were transported to the Science and Technology Research Instruments Centre for analysis.

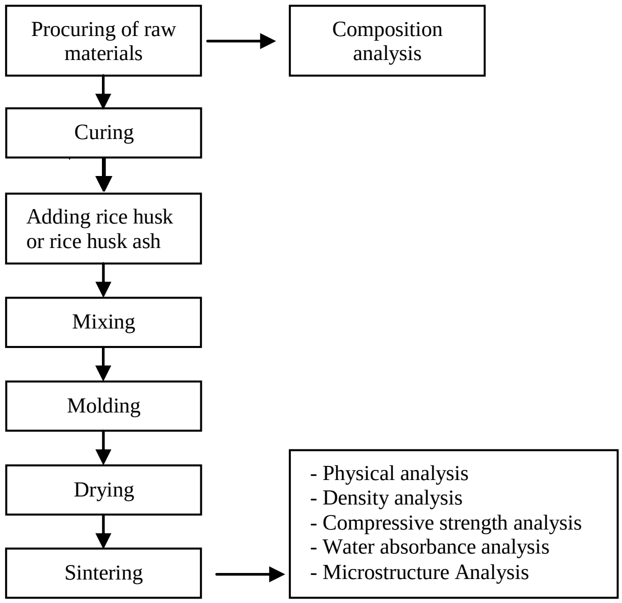


Fig. 1. Schematic diagram of experiment

Figure 1 showed a schematic diagram of brick manufacturing. After the raw material was procured by clay, the main component was cured for three days. The adding rice husk ash in the curing component was 2 percent of weight. Next, the component was mixed and molded by casting, the bricks were cast in sizes of 10 cm × 15 cm × 30 cm. The specimen was then sintered in furnace which varied from 750 °C, 800 °C, 850 °C, 900 °C and 950 °C for 3 hours. Later, the raw brick was analyzed to industrial standards, as compressive strength by a Universal Testing Machine (Dartac model 1000/RF-2), density, percent of water absorption by Archimedes method, heat transfer of clay by thermal differential analysis and structure analysis by Scanning Electron Microscope (model JSM-5410 LV) were all investigations.

3. Results and Discussion

3.1 The composition of raw material from Bang Ban's clay

The composition of elements in the raw material for brick was analyzed and showed that the most of the raw material clay was composed of Silicon Dioxide, Aluminium Dioxide and Iron Oxide. The Silicon Dioxide increased the brick's strength. For Aluminium Dioxide and Iron, they changed the brick pigment to red after sintering [6]. The main component of rice husk ash was Silicon Dioxide. Table 1 showed the major composition of raw material.

Table 1. Composition of raw materials. by percentage

Substance	Clay	Rice husk Ash
SiO_2	60.67	93.59
Al_2O_3	15.18	0.54
Fe_2O_3	7.61	0.82
K_2O	3.12	1.94
MgO	1.15	0.15
TiO_2	1.18	0.07
CaO	0.79	1.45
Na_2O	0.56	0.01
SO_3	0.55	0.94
MnO_2	0.22	0.19
BaO	0.11	0.01
ZnO	0.01	0.04
ZrO	0.01	0.01
Others	8.84	0.24

3.2 Differential thermal analysis, DTA

Differential thermal analysis of soil with main of raw materials was showed in Figure. 2. At 80 °C, soil moisture evaporated from raw materials because endothermic reaction in soil with soil moisture evaporated and there was water loss in lactic structure. When increasing temperature, the inversion of silicon dioxide structure occurred through infrastructure expansion [6].

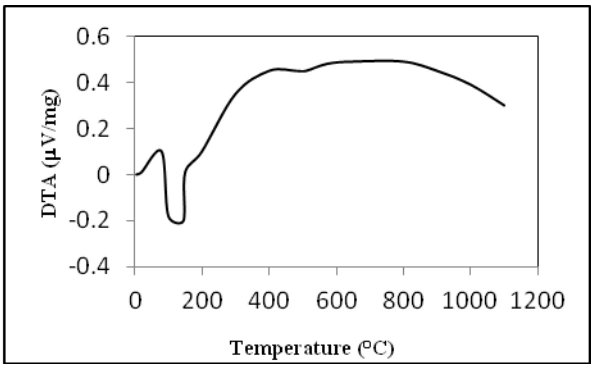


Fig. 2. Differential thermal analysis of soil

3.3 Bulk density and Compressive strength

The bulk densities and compressive strength of the sintered specimen was given in Figure 3 and 4. The graph showed that at 850 °C, it reached the best bulk densities and compressive strength. The bulk densities and compressive strength were high maximum 1.79 g/cm^3 and 14.3 MPa with sintered temperature at 850 °C. However, increased temperature more than 850 °C, the bulk densities and compressive strength of the specimen were decreased because at a temperature higher than 850 °C was evaporating out of the rice husk ash in brick. When the space was instead of rice husk ash, the space increased the porosity with effect to decrease the bulk densities and compressive strength of sintered specimen.

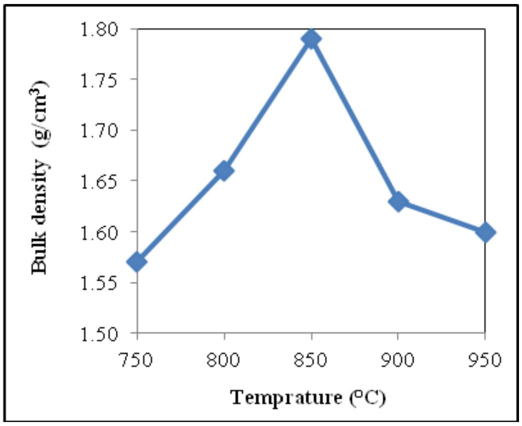


Fig. 3. Bulk density of brick specimen with a different sintered temperature

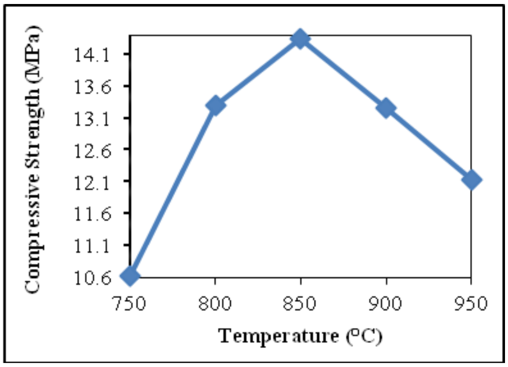


Fig. 4. Compressive strength of brick specimen with a different sintered temperature

3.4 Water absorption and Porosity

The effect of sintered temperature to water absorption and porosity was shown in Figure 5 and 6. At 850 °C, the water absorption and porosity were the minimum. After that, the graph inclined with an increased temperature more than 850 °C. The minimum of graph occurred due to porosity of specimen with evaporation of burned rice husk. Then 850 °C, the minimum of water absorption and porosity was 14.4 % and 28.9 % because composition were their high maximum of density properties

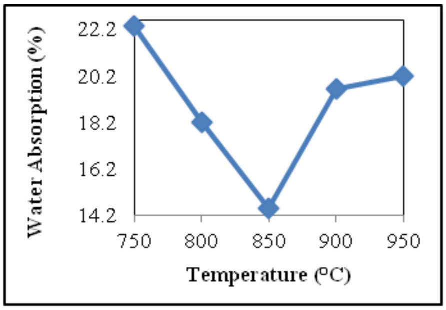


Fig. 5. Water absorption brick specimen with a different sintered temperature

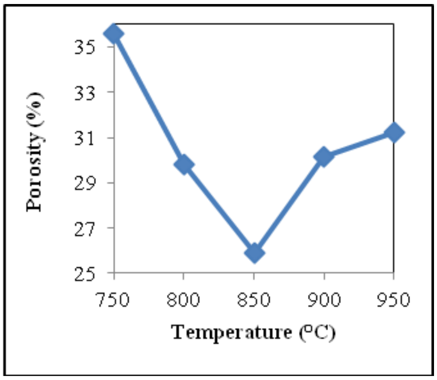
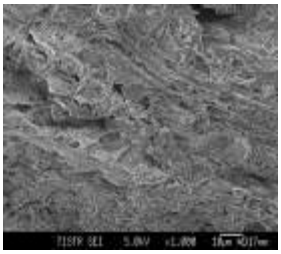


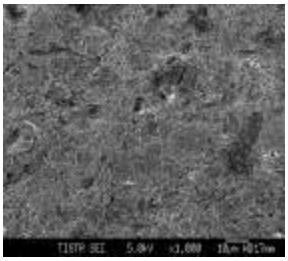
Fig. 6. Water absorption brick specimen with different sintered temperature

3.5 Micro structure

The effect of sintered temperature to microstructure of brick specimens was shown in Figure 6 and 7. When temperature was increased, the grain of specimens showed growth but were non-homogenous because the high sintered temperature caused the evaporation of rice husk ash.



(a)



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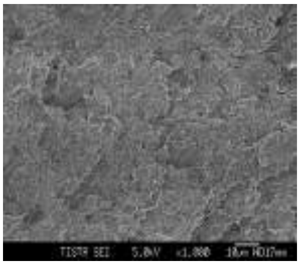

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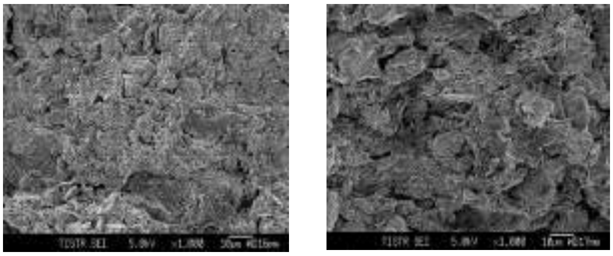

(d) (e)

Fig. 7. Microstructures of modified component brick with different sintered temperature: a (750 °C) b (800 °C) c (850 °C) d (900 °C) e (950 °C)

4. Conclusions

The study found that the optimum sintered temperature at 850 °C showed good mechanical properties of brick. The optimum mechanical properties were 14.3 MPa of compressive strength, 1.79 g/cm^3 of density, 14.4 of water absorption, and 28.9 % of porosity. The optimum occurred because when temperature was lower than 850 °C, then the agglomerations of composition particle in specimen was loose. In contrast when higher than 850 °C, the temperature evaporated the rice husk ash in brick specimens, therefore there was space in brick specimens.

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