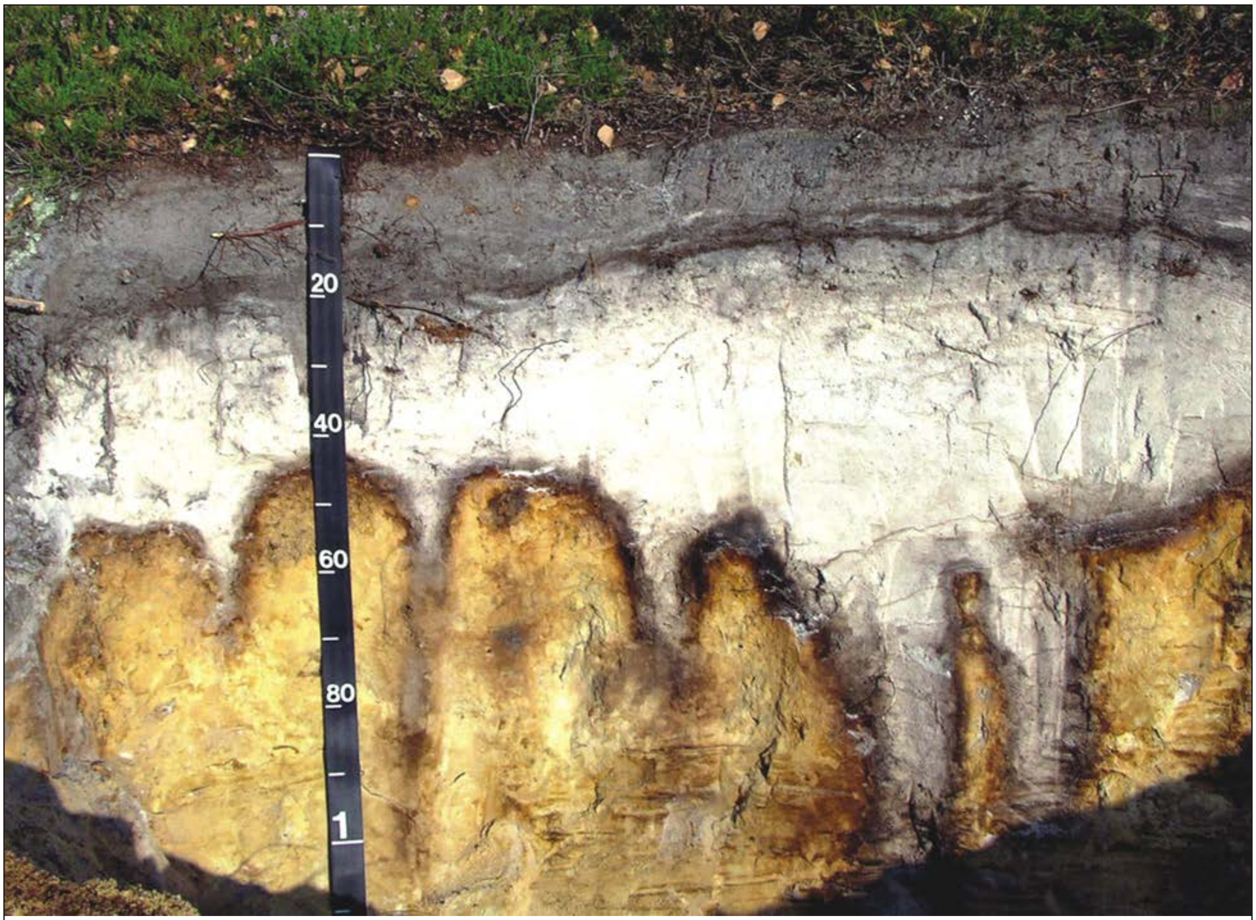

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Reduced Soil Moisture in Producing Soil-Cement Brick for Construction Materials Using Constructed Sieve, Housing Building and Drying in Open Air Methods

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Abstract: This study proposed the solution to reduce soil moisture content in making soil cement brick at factory condition during rainy season. Soil sample of Kalasin province (located in the Northeast region of Thailand) was selected as the case study. There are 3 considered methods of reduction of soil moisture at the factory such as on constructed sieve, housing building with solar energy and drying in open air. The weather condition and thickness of soil sample were considered. The results found that on the constructed sieve method can reduce soil moisture taking duration time about 6-15 days. In this method also varied soil sample level of surface sieve. The reduction of soil moisture at higher level from ground surface is faster than lower level. In case of housing building, the less soil thickness cases reached to the accepted soil moisture faster than the higher soil thickness using duration time of 6-12 days. For the drying in air case, the less soil thickness is also efficient to reduce than the higher thickness. This method used the time for about 5-18 days reducing moisture. The investment cost per quantity of dried soil for the first year and the future 10 and 15 years were investigated. The results found that drying in air case is the lowest and the constructed sieve is the highest. The housing building is the most suitable for using to reduce the soil moisture during rainy season in term of effective reduction and economy.

Key words: Soil-cement, infiltration, laterite soil, soil moisture content

INTRODUCTION

At present, the construction buildings usually face with high material cost. It makes the real estate or house building at present also too expensive. There are many ways for producing lower cost materials in construction building work such as soil cement brick. The soil cement brick make of cement 1 part and soil 8 parts mixed with water (Walker and Stace, 1997; Venkatarama-Reddy and Gupta, 2005). Normally, soil cement bricks are easily used to construct wall structure of the building. They can support the wall bearing load.

The development of soil cement brick must have both knowledge of engineering and materials science. There are many sites of suitable soil that have the property to use as the law material. The suitable soil type is a laterite soil. This is prepared by drying before grinding and sieving though sieve No. 4 (Olufemi, 1989; Walker, 2004). High moisture content is obstructing to produce soil cement brick during the rainy season. However, there are still a lot of consumers in the rainy season.

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Soil moisture content is characteristic of soil that indicates the ratio of water per soil (Karlen *et al*., 1990; Barbosa da Silva *et al*., 2007; Abbaspour-Gilandeh *et al*., 2009). Generally, soil moisture content at field level during rainy season vary about 15-20% (by weight), the accepted soil moisture are 4-5% that accepted for further process of producing soil cement brick. The factory usually stores the laterite soil in the large cover building for producing during rainy season. However, this solution has more investment cost and more area for constructing the cover building. Often, the soil moisture of these stored soils is higher than the accepted condition. There are many methods for reducing soil moisture content but taking a high operation cost (Dingman, 2002; Turner, 2005; Lawrence and Hornberger, 2007; Ahmadi and Mollazade, 2009; Turner and Romero, 2009). The method without energy consumption is considering for applying in the factory.

This study thus proposed the solution to reduce soil moisture content at factory condition during rainy season. Soil field in Kalasin Province (located in the Northeast region of Thailand) was selected as the case study. There are 3 considered methods of reduction of soil moisture content at the factory including on constructed sieve, housing building and drying in open air.

MATERIALS AND METHODS

Soil Classification

Laterite in Kalasin Province was selected to investigate the efficiency of the proposed methods. Figure 1 shows the selected laterite soil of Kalasin province (in the northeast region of Thailand). This site is 35 km from soil-cement brick factory that cover area of 10 km^2. Soil properties that proper to used as law material were investigated. This soil is more than 70% of silica with red brown color. Soil samples were taken to the factory for the study.

Reduced Soil Moisture Methods

There are 3 methods that considered reducing soil moisture content including constructed sieve, drying in housing building and drying in open air. The efficiencies of each method were investigated during rainy season (May to September). The weather factors such

Fig. 1: Laterite soil from Kalasin Province site

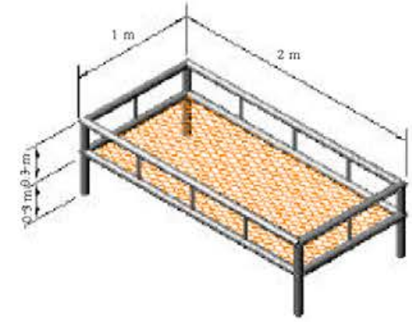

Fig. 2: Typical of the constructed sieve

Fig. 3: Typical of the housing building

as ambient temperature, relative humidity, wind speed and rainfall were record during the study. This research project was conducted from May 2008 to April 2009.

Drying on the Constructed Sieve Method

The steel sieves were constructed for drying soil samples at the factory (Fig. 2). Their columns can be adjusted from 0.3 to 1.0 m over ground. The prepared soil samples were taken to drying on the constructed sieve. Each condition was performed with 3 sieves.

Drying in the Housing Building Method

The housing building was constructed for this study with the size of 3.0×6.0×2.5 m (Fig. 3). The wall made of plastic material, the cover made of mental sheet the others made of timber structure. Moisture flow direction from in site to out site is described in Fig. 4. The soil samples were taken into the housing building for investigating the reduced efficiency. There are 4 samples that investigated in each condition.

Drying in Open Air Method

The concrete floor with 10 cm thickness and the size of 3.0×6.0 m was constructed for drying in open air method. This concrete floor was constructed under the cover. The affect of quantity of soil samples were considered.

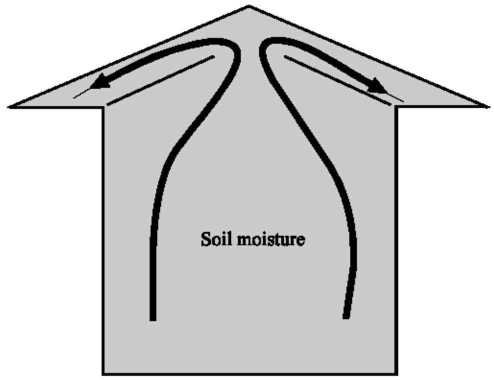

Fig. 4: Air flow direction

RESULTS

Drying on the Constructed Sieve Method

This method investigated the relationship between percent of reduced soil moisture and the thickness of soil sample when the drying process was done until met the accepted condition. The considered thickness soil samples were 20, 40, 60, 90 and 105 centimeters. The height of sieve from ground was adjusted at 30 and 60 cm for supporting air flow. The initial soil moisture content was 13-23% base in soil field condition.

The relationship between the soil moisture and time of drying when the heights of sieve were varied are presented (Fig. 5, 6). They indicates that the on the constructed sieve method can reduce soil moisture taking duration time about 6-15 days. The reduction of soil moisture at level 60 cm from ground surface is faster than at the level 30 cm from ground surface because of effective air flow.

Drying in the Housing Building Method

This method investigated the relationship between percent of reduced soil moisture and the thickness of soil sample when the drying process was done until met the accepted condition. The considered thickness soil samples were 10, 30, 60 and 90 cm. The initial soil moisture content was 13-23% base in soil field condition.

The record of soil moisture and duration time of drying is shown in Fig. 7. They indicates the less soil thickness cases reached to the accepted soil moisture faster than the higher soil thickness using duration time of 6-12 days.

Drying in Open Air Method

For the drying in air case, the thickness of soil samples of 30, 60, 90 and 120 cm are considered in this study. The relationship between the soil moisture content and duration time of drying for drying in open air method is presented (Fig. 8). It indicates that the less soil thickness is efficient to reduce than the higher thickness. This method used the time for about 5-22 days reducing moisture.

Economy Analysis

For the economy analysis, the investment cost of 3 mentioned methods was calculated in term of investment cost per quantity of dried soil (Baht m^{-3}) for the first year and the

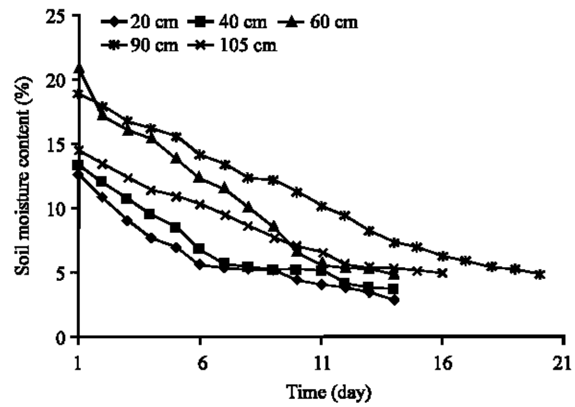

Fig. 5: The relationship between the reduced soil moisture and duration time of drying at the height of 30 cm

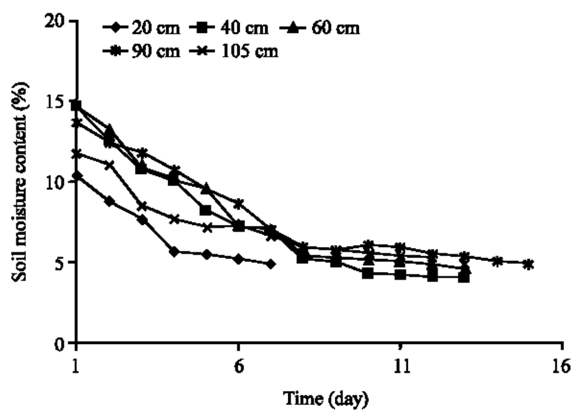

Fig. 6: The relationship between the reduced soil moisture and duration time of drying at the height of 60 cm

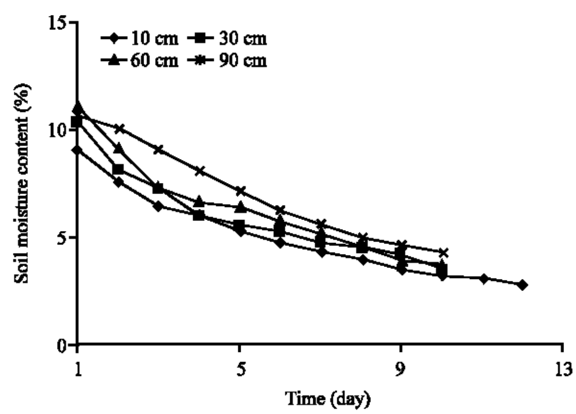

Fig. 7: The relationship between the reduced soil moisture and duration time of drying

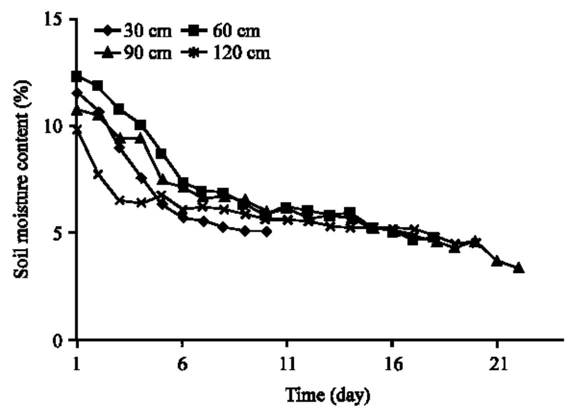

Fig. 8: The relationship between the reduced soil moisture and duration time of drying for drying in open air method

future 10 and 15 years. The results found that the investment cost per quantity of the drying in open air, the drying in housing building and the drying on the constructed sieve are 104, 1,550 and 4,509 Baht m^{-3} day (1 Baht~34 US$), respectively. For this reason, the housing building with solar energy is the most suitable for using to reduce the soil moisture during rainy season intern of effective reduction and economy.

DISCUSSION

There are 3 methods that developed to reduce soil moisture at the factory including drying on the constructed sieve, drying in housing building and drying in open air. The results found that the constructed sieve method can reduce soil moisture taking duration time about 6-15 days based on both the thickness of soil sample and the high plane sieve. They indicated that the thin soil sample can be met the accepted condition faster than the thick sample as reported in drying methods (Turner and Romero, 2009). In addition, the higher level of plane sieve can reduce soil moisture quickly than the lower level. These because the air flows pass through the surface of soil sample and carry water out well (Lawrence and Hornberger, 2007; Ahmadi and Mollazade, 2009). The soil thickness also is affected to the reduction of soil moisture content of the drying in housing building and drying in open air.

The climate parameters such as ambient temperature and wind speed affected to the reduction of soil moisture when the soil samples were drying in the open air according to the previous study (Dingman, 2002). Whereas, the wind speed is not significant effect of reducing the soil moisture content in the housing building.

CONCLUSION

This study proposed the solution to reduce soil moisture content in making soil cement brick with rice husk ash mixed at factory condition during rainy season. Soil field in Kalasin Province (located in the Northeast region of Thailand) was selected as the case study. There are 3 considered methods of reduction of soil moisture at the factory such as on constructed sieve, housing building and drying in open air. The results found that on the constructed sieve method can reduce soil moisture taking duration time about 6-15 days. In this method also varied soil sample level of surface sieve and the final soil moisture are 4-5% that accepted for further process of producing soil cement brick. The reduction of soil moisture at level 60 cm from ground surface is faster than at the level 30 cm from ground surface because of effective air flow. In case of housing building soil samples are considered in several thicknesses including 10, 30, 60 and 90 cm, respectively. The less soil thickness cases reached to the accepted soil moisture faster than the higher soil thickness using duration time of 6-12 days. For the drying in air case, the thickness of soil samples of 30, 60, 90 and 120 cm are considered in this study. The less soil thickness is efficient to reduce than the higher thickness. This method used the time for about 5-18 days reducing moisture.

Climate parameters such as ambient temperature and wind speed are affected to the reduction of soil moisture. However, they are not eminent in the study because the climate situations are similar during the collection of data. In addition, this study was performed under covered building case. However, ambient temperature and wind speed are activated parameters for the reduction process. The high relative humidity is the obstruction of reducing soil moisture content.

For the economy analysis, the investment cost of 3 mentioned methods is calculated in term of investment cost per quantity of dried soil (Baht m^{-3}) for the first year and the future 10 and 15 years. The results found that drying in air case is the lowest and the constructed sieve is the highest. The housing building with solar energy is the most suitable for using to reduce the soil moisture during rainy season intern of effective reduction and economy.

In conclusion, the suitable method for reducing soil moisture during rainy season is housing building. The affected factors are soil sample depth, initial soil moisture, temperature and humidity. The mentioned method is feasible to apply for promoting manufacturer to improve the production process.

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