

## Study on the Physical and Mechanical Properties of Clay Brick Samples in Four Different Locations

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### Abstract

Bricks are commonly used for construction of buildings structures. Common bricks are divided into two types namely as sand brick in white colour and clay brick in red colour. Sample specimens are collected at Pakokku in Magwe division and also samples are collected at Kyuakse, Kume and Tharzi in Mandalay division. These samples are examined for compressive strength, density and water absorption of bricks in laboratory. According to the results, it was found that M-3, P-4, M-2 and M-1 have maximum compressive strength and P-3 have minimum water absorption and porosity. T-5 has highest density. For first clay bricks, water absorption capacity should not be more than 20% by weight. Fire clay bricks are very popular materials in application because they are low costs, fire resistance and very long-term. The compressive strengths were determined by using compressive testing machine (RUB-250).

**Keywords:** Clay Brick, Compressive Strength, Absorption, Density

### Introduction

Clay raw materials differ in composition from one part of a field site to another site of the same environment. Clay is ground in mills; mixed with water to make it plastic and then moulded either by hand or by machine and then dried and fired. Fired bricks have a sandy texture and are irregular in shape and colour, they are used as facing bricks due to the variety of their shapes, colour and texture. The moulded bricks are baked to dry out the water and burned at a high temperature so that part of the clay fuses the whole mass of the brick into a hard durable unit. Clay brick is suitable for brick making because of its wide variation in composition and also possible to burn bricks over a wide range of temperature sufficient to fuse the material into a durable mass. Clay bricks may be classified into first class is 105 kg per cm<sup>-2</sup> (10 Nmm<sup>-2</sup>), water absorption should not be less than 15 %, second class is 70 kg cm<sup>-2</sup> (7 Nmm<sup>-2</sup>), and third class is 35 kgcm<sup>-2</sup> (3 Nmm<sup>-2</sup>), water absorption should not be less than 20 %. An average brick weight to be about 5 pounds (2.27 kg) for standard red clay brick. In different countries different sizes of bricks are used in constructions. The common size measures to be 8 in by 21 or 14 in by 4 in. Bricks are used as a building material for a variety of projects such as wells, fired places and walkways. The unit weight of first and second class bricks should not be less than 1100 kg per m<sup>3</sup>.

Porosity is an important characteristic of brick. In contrast to other moulded or pre-cast building materials, the porosity of brick is attributed to its fine capillaries. Porosity depends on the type of the materials, material size, and composition. In general, that the decrease in porosity in line with the increase in the strength of the soil material. (Paulo B2010)

### Material and methods

Sample of bricks were collected from brick kilns located in different manufacturing area of Pakokku in Magwe division and Mandalay division. Selected manufacturing areas include samples are (P-1 to P-5) collected from Pakokku, Kyuakse (K-1 to K5), Kume (M-1 to M-5) and Tharzi (T-1 to T-5). The collected specimens were brought to the testing laboratory of Yangon Technological University in Yangon for conducting test to evaluate their quality.

### Methods

The objective of these tests were analyzed and investigated the physical properties and mechanical properties of the manufactured bricks. Based on 20 bricks samples collected from different places, testing of bricks were carried out in the laboratories. Physical and mechanical tests were done for the determination of these bricks for compressive strength, water absorption and density.

### Mechanical properties

Mechanical tests conducted on the brick samples include compressive strength of brick. Compressive strength helps to determine the quality and durability of brick to be used in the construction of structure. The compressive strength of the bricks can be determined by using the following formula,

$$\text{compressive strength} = \frac{\text{Maximum load failure (N)}}{\text{Average net area of two faces under compression (mm}^2\text{)}}$$

Physical tests conducted on the brick samples include porosity, specific gravity dimensions, density, hardness test, impact test, soundness test, colour test and water absorption test. Individual clay brick was weighed and then immersed in water for 24 hours. After the completion of the time they were removed and weighed again. The difference between the dry and wet clay brick was the record and calculated. (ASTM C20-00(2015) The water absorption and density of the samples were determined by using the following formulas.

$$\text{water absorption} = \frac{w_2 - w_1}{w_1} \times 100\%$$

where,  $w_1$  = Dry weight of brick

$w_2$  = weight after immersion for 24 hours

$$\text{Density} = \frac{\text{Dry weight of brick}}{\text{volume of the brick}}$$

$$\text{Apparent porosity} = \frac{w_2 - w_1}{\text{volume}} \times 100\%$$

### Results and discussions

#### Mechanical properties of brick samples Compressive strength

There are thousands of types of bricks that are named for their use, size, forming method, origin, quality, texture, and/or materials. The specimens for the compressive strength tests were tested according to American Society for Testing and Materials (ASTM). This test is done to know the compressive strength of brick. It is also called crushing strength of brick. Generally five specimens of bricks are taken to laboratory for testing and tested one by one. In this test a brick specimen is put on crushing machine and applied pressure till it breaks. The final pressure at brick is crushed is taken into account. (ASTM C20-00(2015) The compressive strength of 20 brick samples have been tested under mechanical test of brick. The compressive strength of 20 brick samples are shown in figure1. From figure twenty brick samples have the compressive strength in the range of 3.18 Nmm<sup>-2</sup> to 14.64 Nmm<sup>-2</sup>. The compressive strength of the bricks should be 3.5Nmm<sup>-2</sup> and more than 10 Nmm<sup>-2</sup> which showed the results in figure 1.

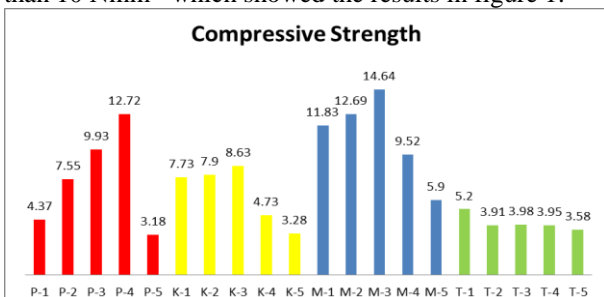


Figure 1. Compressive strength of brick of bricks samples

#### Physical properties of bricks samples Water absorption tests on brick and porosity

Water absorption test on brick is conducted to find out the amount of moisture content absorbed by brick under excessive conditions. Low water absorption is the representation for high compressive strength, durability and good quality of bricks show in figure 2.

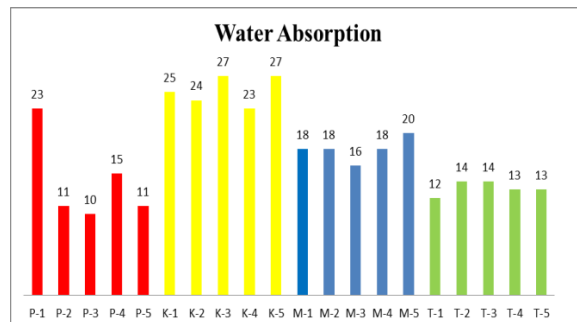


Figure 2. Water absorption for 24 hours results

#### Density

Density varies from country to county as standard size of the bricks. It depends upon the dimension of the bricks. The density of brick should be 1600 kgm<sup>-3</sup> to 1920 kgm<sup>-3</sup>. It is found that 20 bricks samples lie in the range of 1432 kgm<sup>-3</sup> to 1711 kgm<sup>-3</sup> show in figure 3.

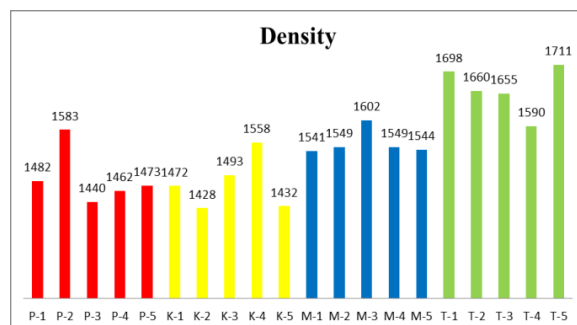
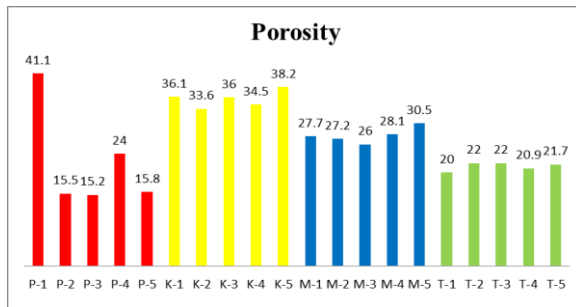


Figure 3. Density of the bricks samples

#### Porosity

Porosity is the volume of the pores within a brick, expressed as a percentage of the total volume of the brick. Porosity is an important characteristic of brick. In contrast to other moulded or pre-cast building materials, the porosity of brick is attributed to its fine capillaries. The degree of porosity depends on the type of clay used to manufacture the brick and the duration and temperature of firing. (Paulo B et al.2010)]



**Figure 4. Porosity for bricks samples**

### Discussion

The present research work was focus to study the physical and mechanical properties of 20 bricks samples for their quality assessment using standard values and the following discussions are drawn from above results and discussion. The water absorption, density and apparent porosity are related for improve of the mechanical property of compressive strength of brick samples used in this study. It shows higher the value of water absorption and porosity, lower the value of density of brick samples whereas physical test for effect hardness, soundness, colour do not show the satisfactory results. The compressive strength tests from all the clay bricks purchased and found to be suitable load bearing except P-5 and K-5 samples ( $3.18$  and  $3.28\text{Nmm}^{-2}$ ), fell below standard recommendation. All bricks samples are used in this study, the compressive strength were  $3.18$  to  $12.72\text{N/mm}^2$  for Pakokku,  $3.28$  to  $8.63\text{N/mm}^2$  for Kyuakse,  $5.9$  to  $14.64\text{N/mm}^2$  for Kume and  $3.58$  to  $5.2\text{N/mm}^2$  for Tharzi, respectively. The values of water absorption were  $10$  to  $23\%$  for Pakokku,  $23$  to  $27\%$  for Kyuakse,  $16$  to  $20\%$  for Kume and  $12$  to  $14\%$  for Tharzi, respectively. The density values were  $1440$  to  $1583\text{kg/m}^3$  for Pakokku,  $1428$  to  $1558\text{kg/m}^3$  for Kyuakse,  $1541$  to  $1602\text{kg/m}^3$  for Kume and  $1590$  to  $1711\text{kg/m}^3$  for Tharzi, respectively. Finally, the apparent porosity are from  $15.2\%$  to  $41.1\%$  for Pakokku, from  $33.6\%$  to  $38.2\%$  for Kyuakse, from  $26\%$  to  $30.5\%$  for Kume and from  $20\%$  to  $22\%$  for Tharzi. The higher value of water absorption and porosity, lower the value of density for brick samples.

Although the compressive strength of the bricks sample are increased with increasing their density. Therefore clay bricks purchased are used suitable.

### Conclusion

All clay bricks samples purchased from the manufacturer have attained or reached 30 days, at this stage these bricks should have attained highest compressive strength. It may be necessary to take laboratory sample tests in advance before purchasing clay bricks for building construction. Construction industry should motivate investors to use clay brick because of their long term and low cost of maintenance.

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