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CRITICAL REVIEW ON TYPES OF BRICKS TYPE 4: ADOBE BRICKS

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Abstract - Adobe is one of the oldest building materials in use and abundantly found everywhere with affordable and reasonable cost. It is basically just dirt that has been moistened with water, sometimes with chopped straw or other fibers added for strength, and then allowed to dry in the desired shape. In addition to being simple and economic, adobe bricks are fireproof, durable, non-toxic, possess low sound transmission levels through walls and provide sufficient thermal mass to buildings. Adobe brick walls are load bearing structures, which can be used to build up to several stories high. Also, adobe bricks have ability to build vaults and domes. In addition to this, adobe bricks afford great flexibility in the design and construction process. They can be simply cut, reshaped and can easily be subjected to opening to be used for building's services.This paper present an review on the adobe bricks

Keywords - Adobe bricks history, process of manufacturing, tests, advantages

I. INTRODUCTION

The word "ADOBE" is used to designate a particular kind of soil and there prevails a general impression that this material is essential for the making of sun-dried brick. Most clayey loams, except those with a high clay content, are suitable, but it is not practicable to make a selection on the basis of soil analyses. Soils having a high Adobe is another terminology used for mud brick construction which is an Arabic and Berber word brought by Spaniards to the Americas, where it was adopted into English. Adobe has been used for building for thousands of years. Basic Adobe bricks are made by mixing earth with water, and placing the mixture into moulds and left drying the bricks in the open air, away from direct sun. Mud mortar is used to join mud bricks together and can also be used as a plaster to cover the internal and external walls [1], [2].Spanish word "adobe" referred to a sun dried brick, which are prepared by molding the mud manually. However machines are also used to mold adobe, but molding manually is an old practice. Construction with adobe is still highly practiced among the communities of developing countries as it is affordable and economical [6]. Local people use their experiences and rough estimation in producing bricks manually [7]. Mud is considered inexpensive, broadly available and found environmentally friendly. It consists of stones, sand, silt, clay, and organic humus. Adobe construction is unsophisticated technique; easy-to-learn, and does not need specialized skills. This construction process relies greatly on human labor and creativity instead of on capital or high technology [3].Earth has been used in the construction of shelters by mankind for thousands of years [4], and approximately 30 percent of the world's present population still live in earthen dwellings [5]. Adobe, and other forms of earthen structures, are manufactured throughout the world and use the simplest of materials: earth (clay, silt and sand) and water. The actual composition depends upon the raw materials which vary around the world. Due to the inherent weakness of earth in water, most surviving archaeological and abandoned historic structures are located in arid or semi-arid environments. Many inhabited, and therefore maintained, earthen structures exist in areas of high rainfall. Because adobe is one of the earliest known materials, it is not surprising that a number of the world's significant cultural structures are composed of adobe. However, many of these historic structures have a very tenuous existence.To produce adobe brick, soil is required which is comprised of three main contents, sand, silt and clay [8]. Soil is available locally in almost every part of the world and also its manual production makes it cheaper for the people who lack economic resources. Production of adobe bricks compared to the other bricks requires less energy. Apart from these benefits adobe stores heat in winter and transmits heat in summer to maintain the indoor temperature. These benefits fulfills the requirement of an adequate house, which is why it has been adapted by 50% population of world [9, 10]. However, adobe houses are not properly maintained which in result leads to the failure when environmental consequences and natural disaster triggers [8, 10, 11]. It has been observed that adobe houses cannot bear the excessive dead loads due to limited compressive strength property, as in monsoon it collapse on the increase of dead load of roof due to rains [12, 13].

II. HISTORY

Adobe mud blocks are one of the oldest and most widely used building materials. Use of these sun-dried blocks dates back to 8000 B.C. (Houben and Guillard 1994, referenced in EERI adobe tutorial). The use of adobe is very common in some of the world's most hazard-prone regions, such as Latin

America, Africa, the Indian subcontinent and other parts of Asia, the Middle East, and southern Europe. Around 30% of the world's population live in earth-made construction (Houben and Guillard 1994). Approximately 50% of the population in developing countries, including the majority of the rural population and at least 20% of the urban and suburban population, live in earthen dwellings (Houben and Guillard 1994). By and large, mainly low-income rural populations use this type of construction.

III. METHOD OF MANUFACTURING OF ADOBE BRICKS

Adobe bricks consist mainly of a mixture of sand and clay to which, in order to conform with the requirements of the uniform building code, a waterproofing substance is added. A good general way to regard the sand and clay in an adobe is to like them to the components of concrete. In this comparison, the sand in the adobe fills the role of the sand and gravel aggregate in concrete; in other words, it is an inert filler. Clay in the adobe is the binder, as is the cement component in concrete. Even as the proportion of cement in concrete is less than that of the aggregate, so a proper adobe brick mix usually - contains less clay than sand. This is true even though a popular misconception is that adobe bricks must be made of high clay content "adobe" soil. Remember that when "adobe" soil dries out under the summer sun it shrinks up and develops numerous wide and deep cracks, an effect not wanted in adobe bricks. The uniform building Code states that the clay content of adobe bricks must be greater than 25% and less than 45%. Too much clay and the brick develops cracks as it dries and the brick will be too weak when it dries and will crumble easily. Adobe blocks are made from a mixture of clay-based soil, water, and sometimes straw. Wet adobe is formed into bricks and then laid out to dry in the sun for several days. The greatest disadvantage of adobe is its vulnerability to water and rain. Sometimes adobe is locally regarded as 'the material of the poor', which may restrict its application [17]. Adobe blocks are used for the construction of walls, with wet adobe serving as the mortar. Methods of construction vary considerably by climate. Most homes have a coating of adobe on the outside to create a smooth surface, which can be painted. Adobe is applicable in rural areas but in urbanizing areas, with higher densities, the use of this sustainable material is not very common [18]

IV. PROCESS OF MANUFACTURING OF ADOBE BRICKS

Adobe brick is a simple technology that requires only the mix of native soil, clay, sand and additional organic matter such as dried grass or straw. Desirable native soils for brickmaking are those classified as loamy sands, sandy loams, or sandy clay loams.

Preparing the soil

Only a sufficient quantity of soil for a day's work should be pre pared at one time. The proper amount is piled in a 3- or 4-inch layer, wet thoroughly, and puddled into a mucky mud, generally by men tramping barefooted through the mass, or by mixing with a mortar hoe. When the earth is uniformly wet, straw is thrown on top of a layer upto 1 and half to 2 inches thick and tramped into the mud. To prevent the straw being worked to the bottom of the pile it should not be added until after the soil has been well puddled. Water is added as necessary to produce a mixture plastic enough to be handled with a 6-tined fork yet stiff enough to stand up upon removal of the form. The quality of the brick is improved by thorough puddling, therefore a hoe should be used in the process. The amount of straw required varies with different soils and is best determined by experiment. Occasionally brick are made without straw, but generally from a little less than a bale (lOG pounds) to one and half bales per 1,000 brick will be needed depending upon the soil and size of bricks. The quantity should be sufficient to bind the mud and to prevent excessive cracking of the brick while curing. For the best adobe bricks soil of appropriate quality should be used for that purpose the test of soil should be done fill a container about 2/3 full of soil. Add water until the jar is full, and stir it for about 2 minutes. Set the container down and let it sit overnight. When you check the content, the soil should be broken up into two distinct bands of dirt. The sand should be settled on the bottom with the clay on the top. There should be more sand than clay. A ratio of about 70 percent sand to 30 percent clay is ideal for making adobe brick. This kind of soil is usually available on the top or a side of a natural hill.

Sieving process

After finding the right soil for manufacture Adobe brick, it must be sieved for filtering and screening. The holes of the sieve should have the diameter the same as the minimum diameter of the gravel particle size (i.e. 2mm), because there is no need of large gravel in the soil for Adobe brick production.

Mixing of materials

Making adobe brick is a simple yet effective technology. After identifying the soil to use, it is only a matter of mixing the soil with water and some fibres for strength. Mix the element on a waterproof tarp until the mixture turns doughy and mud-like. We trample the mixture, and then we add dried straw or hay. It is also common to dig a small square on the ground to do the mixing.

Placing of material in mould

Fill the inside of the mould with the adobe mix, be sure to press it as hard as you can to squeeze out excessive liquid. Fill each form completely and level

it off with a shovel. Let the brick set and then remove the mould, repeat the process until you get your desired amount of brick.

Sun drying of bricks

The next step after moulding the brick is to give it time. Leave the brick to dry without moving it. When the edges turn white, you may turn the brick on the other side to let it completely dry. It is important to leave the brick to dry completely as wet/moist brick will have less structural strength. Be patient as this process could take more than 3 weeks depending on your local climate and temperature. The adobe brick are ready to be utilize when it is completely dry and solid.

V. MATERIALS SELECTION OF INGREDIENTS

Additives

The additives are components that when mixed with mud, improve its physical properties and its performance. These physical properties are: compression strength, density, porosity, water absorption, depth of penetration, abrasion resistance and hardness. The common additives can be divided in to three categories: minerals, synthetic and organic materials. There are two sources of organic materials; a vegetable source, e.g., straw, palm leaves, and rice husks, and an animal source, e.g., animal hair and dung) (Torraca, 1988). The additives should be water resistant, not closed pores and capillaries, and they should have good penetration. They ought to increase the mechanical strength and abrasion resistance. They must be durable, easily applicable, cheap, and reversible and they should not be chemically hazardous [4].

Sand

Sand's much smaller between 0.06 and 2 mm. Sand helps to limit the quantity of cracking due to both the shrinkage that appear during the initial drying as well as the expansion that results from relative amounts of moisture at other times. However, extreme amounts of sand can lead to weak, crumbly bricks. Any sand is usable in making bricks, except beach sand, which contains a huge amount of salt. Because salt is hygroscopic material and it has negative consequences for building materials.

Clay

Clay is the key component in adobe bricks. It is a fine grained (approximately 0.002mm) soil material, which consists mainly of microscopic clay mineral particles. Clay makes bricks dense, acts as a binder, and increases the resistance to water erosion. Clay holds bricks together as cement in a concrete block. Nevertheless, too much clay is unfavorable to brick composition, since it may cause them to shrink and crack in the dry heat. The origin of clay minerals is found in the interaction of water and rocks (silicate minerals). It can be written as "water + rock = clay." This shows that the clay is hydrous - and more so than the minerals in most rocks. There are several various kinds of clay and all of them are usable for making adobe brick.

Straw

Straw serves as a stabilizing material, to make admixture less sticky and more workable during the actual mixing process and, most importantly, it helps to improve the tensile strength of adobe bricks. In other words, straw binds a brick together and allows it to shrink without cracking.

Mould

A mould can be nothing more than 4 boards tacked together with a couple of handles added, but there are refinements which can be incorporated to achieve more uniformly shaped bricks. Adobes looks best when they come in large sizes. The standard sizes for adobes are: $4x7^{1/2}x16$ inches, used in double courses with a 1 inch mortar joint for the 16 inch wide bearing walls in solid wall construction and also in the curtain walls of post and beam construction, and 4x12x18 inches used in solid wall construction for non-bearing walls.

VI. DRYING AND CURING OF ADOBE BRICKS

In a few days, depending upon the weather, the bricks are stood on edge on such manner as to insure fairly equal exposure of the two sides to the sun and wind and allowed to dry for a week When dry enough to handle, the loose dirt and straw are scraped from the bottom of the bricks, which are then piled, protected from rain and left to cure. Two or three weeks are generally required for the brick to dry sufficiently for use. Brick should not be made in freezing weather or when the season is unsuitable for drying. Care must be taken to protect uncured brick from frost as they will disintegrate if frozen before being thoroughly cured.

VII. TESTING OF ADOBE BRICKS

Bricks should be passes through the following tests

Compression test

Adobe brick units of different nominal dimensions were fabricated for axial compression tests, as reported by Blondet and Vargas [1978]. The two types of units had 0.2x0.4x0.08 and 0.3x0.6x0.08 m nominal dimensions. The bricks were made of clay soil mixed with straw, and dried under the sun for approximately 2 weeks. Blocks are air dried for 1 day and then stacked and moist cured for the following 28 days by covering them with gunny bags and keeping them moist. After 28 days, the blocks are dried and tested for dry compressive strength. The blocks are loaded under a compression testing machine, until the blocks fail under compression. For better consistency of results, 2 specimens per combination is tested. Similarly, blocks are also tested for wet compressive

strength after immersing the blocks for 24 hours in water [14].

Initial Rate of Absorption

Initial rate of absorption is defined as the number of grams of water absorbed in one minute over an area of 30 square inches of brick bed area (ASTM C 67). Accordingly, the test specimen is placed in standard IRA test setup for a period of 1 hour and weighed. For better consistency, 2 blocks per specimen are tested simultaneously and results are obtained in grams/ min/ 30 sq inch. The limiting value as per ASTM for IRA is 30 g/ min/ 30 in^2 [15].

Water Absorption

Water absorption test is a test conducted over 24 hours to determine the quantity of water absorbed by a block. At first, cured specimens are air dried for a day and then it is submerged in water at a temperature of 27 0C for 24 hours (IS 3495) [16].

ADVANTAGE OF ADOBE BRICKS

1. It uses natural and readily available material that can be found around you
2. Many people find the pattern and texture of Adobe walls very attractive
3. Small Adobe units provide great flexibility in the design and construction of earth buildings. Adobe bricks can be easily cut for fitting and can be provided with holes for reinforcing and services
4. Due to the production process and the nature of clay, adobe bricks have good water resistance. Never the less it is very important to provide adequate weather protection of the earth walls, especially in exposed situations.
5. Risk of extensive shrinkage and cracking, which would otherwise occur in soils of high clay content in a large monolithic wall, is prevented, as the brick are dried totally before being use.
6. No costly tools or equipment are necessary and the essential know-how can be easily acquired on a training workshop and through hands-on experiences, or by a simple search on the Internet.
7. It has low sound transmission levels through walls and a general feeling of solidity and security.
8. Adobe bricks are a fireproof, durable yet biodegradable, non-toxic building material which provide sufficient thermal mass to buildings to ensure excellent thermal performance

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