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Experimental Research on the Recyclability of the Clay Material used in the Fabrication of Adobe Bricks Type Masonry Units

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Abstract

In the sustainable development context, the possibility of recycling, reuse and reintegration in nature, environmental protection and efficient management of natural resources are significant indicators. *Adobe bricks type masonry units* meet successfully these requirements. This paper presents a series of experimental research conducted to explore the clay material recycling possibility of the adobe bricks type masonry units, previously used for various purposes. The used testing methods were chosen so as to pursue the preservation or not of some essential physical and mechanical characteristics (mechanical strength, density, axial shrinkage, thermal conductivity). The results indicated the followed parameters preservation for the specimens performed from recycled clay, compared to similar specimens, in whose composition has not been introduced recycled material. Also, the experimental results have indicated the reinforcing possibility with vegetable fiber (straw or hemp fibers), even if the binder was made using the recycled clay.

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Keywords: adobe bricks; sandy clay; recycling; hemp fibers; straw.

1. Introduction

The adobe bricks building history begins in Mesopotamia, since 10,000 years BC [4, 13, 14]. Over time, this material has undergone some changes in terms of composition, but, however, currently too, the adobe bricks

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represent the handmade bricks of clay and sand, with various organic nature additive, animal or vegetable, which can be dispersed reinforced with animal or vegetable fiber.

The literature refers to this building material as being clean; environmentally friendly; easily obtained with little financial and energy effort; which adapts to users' needs; which helps to regulate indoor air relative humidity at 50±5%, throughout the year; no toxic emissions; fire resistant; resistant to insects, rodents and mold attack; sustainable [7, 11, 12, 15, 22]. However, the literature indicates, also, some disadvantages, including the reduced resistance to water, reduced performance to seismic actions, the need for maintenance and repairs more frequently than in the case of sintered construction materials, the need of an effort to establish the optimal composition clay - sand - additions, these varying from one extraction location to another [1, 5, 6, 9, 16, 17].

As it is known, the main raw material needed to adobe bricks manufacture is the clay. The usual term of loam does not represent a standardized composition, but rather it means the clay material extracted from the natural deposit. Depending on extraction location, in its composition are found varying amounts of clay, silt, sand, aggregate, water. Depending on their ratio, ther are defined several types of so-called clay/loam. According to bibliographic, an amount of min. 5%, but no more than 50% clay in the extracted material from the natural deposit, it is optimal for achievement of adobe bricks. [10]. The clay itself is characterized as all clay minerals in a poly-dispersed state, from the extracted material from the natural deposit. These clay minerals are aluminum hydro-silicates arranged in characteristic elementary sheets. The clays plasticity is largely due to water intercalated between the elementary sheets, water works as a lubricant. [21]

Currently, there are many adobe bricks buildings, in poor or economically developed countries. As a result of user interest for this type of construction, many developed countries have proposed and implemented standards that regulate the housing earth construction. New Zealand has a tradition in this area beginning in the nineteenth century. In terms of mechanical strength, the ASTM D1 633-00 New Mexico Code indicates a compressive strength of the material, the minimum needed for the walls of earth, of 2.07 N/mm2. The Code on the beaten earth walls, in Zimbabwe, requires, for 400 mm wall, a minimum compressive strength of 1.5 N/mm2, to one level houses, and of 2.0 N/mm2, in the case of two levels houses. Australian standard indicates a minimum compressive strength of 1.15 N/mm2, and ASTM International E2392/ E2392M-10e1 (2010) indicates a value of 2068 N/mm2. ACI Material, Journal Committee indicates a compressive strength depending on the earth composition, as follows: 2.76 to 6.89 N/mm2 in the case of sandy earth, and from 1.72 to 4.14 N/mm2 for clay soil [8 18, 19, 20].

Although adobe bricks was always presented as being a sustainable material, multi-recyclable, so far, in the literature, there are not presented experimental results of some research on adobe bricks type units performance, to which manufacture was used, not a freshly extracted clay, but a clay material resulting from the old adobe bricks recycling, used, damaged, requiring replacement. Therefore, the aim of this paper is to analyze the achievement opportunity of adobe bricks type masonry units using recycled clay material from adobe bricks type masonry elements, previously used for various purposes. Specifically, in this case, the clay material was recovered by recycling of some previously used in laboratory specimens, for various experimental research, in particular on surface treatment solutions for increasing its water resistance.

2. Methods and materials

To accomplish the proposed objective, that to analyze the possibility of recycling of clay material recovered from the clay masonry elements, adobe bricks type, were made by casting in metal molds, two types of samples:

- Prismatic specimens (40 x 40 x 160 mm) to determine the bulk density of the material reached to equilibrium moisture, the axial contractions, the flexural tensile strength and the compressive strength.
- Prismatic specimens (300 x 300 x 40 mm) to determine the thermal conductivity coefficient through flowmetry method.

Witness specimens: The used material for witness specimens had, initially, an established composition, as the optimal one, by preliminary experimental research, and had included sandy loam, sand 0-4 mm, bone glue and paste lime. In this mix, 35% was the amount of sand and 65% was the amount of binder composed of 97% sandy loam, 1% bone glue and 2% paste lime. The required water was established, also, on the basis of preliminary research and it was 33% reported to the dry material mass.