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EFFECTIVE METHODS IMPROVING THE LOAD-BEARING ABILITY OF CLAY BRICKS AND WALLS

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ЭФФЕКТИВНЫЕ МЕТОДЫ УЛУЧШЕНИЯ НЕСУЩЕЙ СПОСОБНОСТИ СТЕН ИЗ ГЛИНЯНОГО КИРПИЧА

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Abstract. An analysis of major earthquakes over the last 60 years reveals the preponderance of structural damage, building collapse, and fatalities to have occurred in individual buildings of the residential sector. This highlights a serious problem in the rural districts of Central Asia, where more than 65 percent of residential construction uses clay-based materials. For these reasons we are currently developing new ways, based on the old time-honored techniques, to improve the strength and durability of clay as a building material so that locally constructed houses are better able to withstand seismic effects. In this paper presents the third methods of improving traditional building technologies and clay's ability to withstand seismic forces. These methods are short fibers, thermoprocessing and of compacted soil cement block and brick which based to inexpensive materials.

Аннотация. Анализ крупных землетрясений за последние 60 лет свидетельствует о преобладании структурных повреждений, разрушении зданий и летальных исходах в отдельных зданиях жилого сектора. Это является весьма важной проблемой в сельских районах Центральной Азии, где более 65 процентов используемого в жилищном строительстве материала, составляет глина. Для повышения устойчивости построенных домов к сейсмическим воздействиям в настоящее время нами разрабатываются новые способы, основанные на старых, проверенных временем методах повышения прочности и долговечности глины в качестве строительного материала. В этой статье представлены три метода для улучшения традиционных строительных технологий и способности глины противостоять сейсмическим силам. Эти методы отличаются добавлением короткого волокна (отходы текстильного производства), термообработкой и прессованием полусухого грунтоцемента с добавлением отходов. Все используемые компоненты этого нового материала — дешевое местное сырье.

Keyword: clay cement block, brick, clay walls, building.

Ключевые слова: грунтоцементный блок, кирпич, глиняные стены, здание.

Introduction

Since ancient times, clay walls were widely used by the people of Central Asia to construct homes and fortresses, mosques and temples. Indeed, despite the more recent industrialization of construction and widespread use of concrete and steel, the majority of apartment houses and family dwellings, in particular in village areas, are still built from clay, an ecologically pure and accessible material having numerous economic advantages.

For example, one such advantage is that the traditional, massive clay walls with few openings keep buildings cool by day and warm at night in arid regions. Clay-based construction also allows residents to modify their buildings easily in response to changing needs over time. Specific building techniques vary from region to region in response to climatic conditions and ethnic traditions.

An important point that has to be considered when constructing new buildings in Central Asia is the possibility of earthquakes in this seismically active region of the globe [1].

When worked with traditional methods, clay has been proven to make stable and enduring buildings. In Uzbekistan, the centuries-old clay fortress walls and buildings of the cities of Khiva, Khazarasp, and Bukhara testify to the ability of local architects to construct such long-lasting buildings using traditional methods and earth-based construction materials. By contrast, many more recently constructed buildings have not stood up well to seismic forces.

Two significant factors in the collapse of newer buildings have been the loss of such traditional building skills and knowledge and the consequent dilution of vernacular building methods through their unskillful combination with modern industrial elements.

For example, the use of heavy ferro-concrete coverings over clay structures increases the impact of seismic forces and often causes the collapse of walls that would otherwise have withstood the shock. Furthermore, inspection of buildings constructed with a mixture of raw and burned brick, or adobe and burned brick, reveals significant cracks caused by deformation as the two materials dry and respond to climate differently [2].

An analysis of major earthquakes over the last 60 years reveals the preponderance of structural damage, building collapse, and fatalities to have occurred in individual buildings of the residential sector. This highlights a serious problem in the rural districts of Central Asia, where more than 65 per cent of residential construction uses clay-based materials. For these reasons, researchers at Tashkent Architectural–Building Institute and Urganch state university in Uzbekistan are currently developing new ways, based on the old time-honoured techniques, to improve the strength and durability of clay as a building material so that locally constructed houses are better able to withstand seismic effects [3].

Research methods and results

As part of our attempt to understand and improve upon traditional technologies, and to increase clay's ability to withstand seismic forces, we have experimented with a variety of methods. One of the successful methods is the reinforcement of clay with short fibres, such as the wastes from textile and carpet weaving, because of 90 % of wastes synthetic (Capron, nitrogen, wool, viscose and others) and in contrast to plant fibres it stable to biological influence, as well as acids and alkali. As a result of investigations considered to use separate short fibre wastes for the clay strengthening [4].

In laboratory trials, we dried and pounded clay until it passed through a 1/8-inch (3-millimetre) sieve. Then we mixed one-third of the clay with fibres and water before mixing it into the rest of the clay. We formed the clay mix into cubes and prisms and tested them with a hydraulic press. The best results were obtained with a 1 to 1,5 per cent thin fibre mix, which had a compressive strength of 580 pounds per square inch (psi) or 4,0 mega Pascal's (Mpa). This was 53

per cent stronger than pure clay, which had a strength of 375 psi (2,59 Mpa). As well as during the tearing 62,4 psi (0,43 Mpa) for the clay with fibre, and 42 psi (0,29 Mpa) for the pure clay. Mixes with 8 per cent fibre had a strength of 406 psi (2,8 Mpa). After compression, the mixed clay samples retained their form with just a few hair-sized cracks appearing on their surface. After additional pressure, the pure clay samples collapsed, leaving the clay mix cubes and prisms with bigger cracks and distorted shapes.

Knowing about the effectiveness of clay reinforcing by fibrous materials we made bricks from the clay conclusion n with sizes of 10 by 5 by 3,5 inches (250x120x88 mm), blocks with sizes 390x190x140 mm and 23 by 20 by 47 inches (580x500x1200 mm) (Figure).

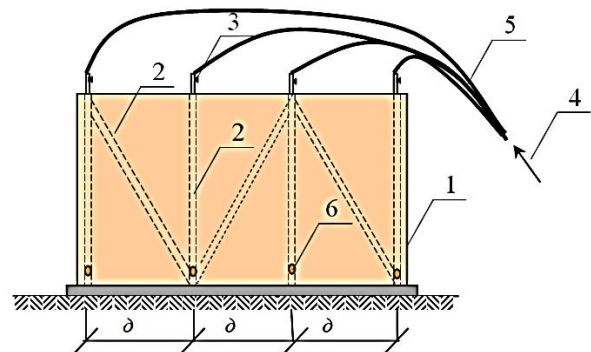
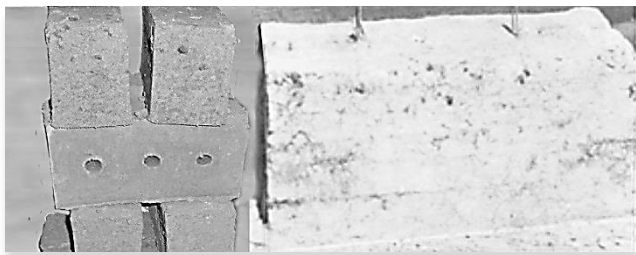


Figure. Figure captions:

1. A variety of block sizes, from 10x5x3,5 inches (250x120x88 mm) to 23x20x47 inches (580x500x1200 mm), were made to test the strength of fibre-reinforced clay.

2. The process of heat treatment of a wall: 1 – walls; 2 – artificial channel in the wall; 3– burner; 4– gas; 5– rubber hose; 6- air apertures.

A second method for improving the bearing strength of clay walls involves thermo processing. According to information passed down through countless generations, when fortress walls were built from clay, longitudinal canals were left in each layer, and the fire was kindled in these canals for several days. Seeking to emulate our ancestors' experience, we experimented with similar thermal processing techniques using both individual brick samples and test-sized clay walls. All of the samples in these tests were fibre-reinforced [5].

Because the purpose of the experiment was to emulate traditional experience, we did not attempt to control temperature and fuel expenditure during thermal processing, which continued for four hours. Samples were then cut from the walls and subjected to compression tests, revealing a 25,7 per cent increase in compressive strength for heat-treated reinforced clay over heat-treated pure clay.

Further experimental research was carried out in field tests on specially constructed free-standing wall samples. During this process, each successive wall layer was built of newly formed bricks, allowed to air dry, and then heat-treated by means of torches inserted in vertical and diagonal cylindrical channels, located within the walls. After each layer of the wall was fired, another layer of bricks was added, being careful to align the cylindrical channels in the bricks correctly, and the drying/firing process was repeated. Once the entire wall was heat-treated it was plastered and white-washed in order to enable easier detection of possible deformations and cracks during subsequent tests of vertical and horizontal loadings, both separately and in aggregate. Strain gauges, indicators and fluorometers were used to measure any deformations. In this case, the reinforced walls proved to be 28 per cent stronger than non-heat-treated walls that were made of clay alone.

Besides its relatively low compressive strength, another weakness of untreated clay is its vulnerability to freeze-thaw cycles. Over time, a weak spot in typical clay wall design is its foot, where contact with moist soil can cause the wall's base to become strongly humidified. This problem can also occur at other spots where walls may come into contact with water, such as near a water pipe, water drain or as the result of a leaking roof.

Thermo processing also offers a possibility for improving this. In the lab, we heated clay in a muffle furnace at temperatures between 265 and 750 degrees Fahrenheit (130 and 400 degrees Centigrade) for two to four hours.

At these temperatures, low-melting-point synthetic fibres stick to each other in the clay, binding it more tightly and making it more waterproof. Reinforced clay samples including different percentages of fibres were exposed to 5, 10 and 15 alternate freezing and thawing cycles; subsequently, mechanical tests were carried out.

The frost resistance of clay reinforced with 1% fibres (series 3), processed at 400 degrees Centigrade for 4 hours, and did not exceed 5-8 freeze-thaw cycles. Samples from series 8 (5 % fibre content), processed at 220 0c for 4 hours, withstood 5-6 freeze cycles. Samples processed at 400 0 c for 4 hours, however, withstood 12-15 freeze-thaw cycles. These results indicate that both fibre-reinforcing and thermo processing help clay to become more freeze-resistant and waterproof. However, the specific durability of such bricks depends on both the temperature and the length of thermal processing, as well as on the percentage of fibres used in the clay-fibre mix.

The third method is a method of compacted soil-cement block and brick. To determine the optimal composition of the new cement mixture, the cement content in the mixture will vary by 4, 5, 6, 8, 12%, fibrous waste to 0.3-1% compared with the unmodified and uncompressed solution. At the pressing samples, the number of changes in pressure and the cement mixture of the sleeve is semi-dry. The sample slug is dried and dried in a 3 mm sieve. In the amount of water allocated to 1/3 of the grass, add 2-3 minutes. Mixed In the mixing mixture formed in the propeller mixer, the solution and cement mixture are left dry and added in small quantities and mixed until they receive the same composition. The resulting mixture should be sewn by hand and not swallow.

Prisms with sizes 70,7x70,7x70,7 and 100x100x100 mm, 100x100x400 and 70,7x70,7x290 mm to determine the strength and deformation of the cement material are produced by pressing the metal on the press. Samples were stored and tested at the temperature + 200±20 for 14 and 28 days.

Modern physicochemical research methods were used in the study of physical mechanical and exploitation properties of samples obtained from experiments. In some cases, laboratory samples were analyzed, and in some cases, samples taken on the basis of semi-industrial tests were used. The experimental data analysis demonstrates the increase of cement content in the cement mass of the cement, the mechanical strength of the product against friction, durability in the extrusion and the fracture, and the positive changes in the frost resistance indicators. The loess-like loam based cement is used for waste and pressing the mechanical strength of the cement samples and the operational properties of the cement are changed to a positive extent. The sampling rate of the airflow moves to the positive side when the amount of pressing increases, i.e less than 1-2%. The amount of fibre in the sample increases with durability and 0.8-1.2 MPa.

Conclusion

Building materials prepared on the constructed building, the second method also itself, but after the building is restored and the third method is produced at the plant itself. All of these methods has its own effectiveness, and the third method is the most efficient and resource-saving method.

These experiments suggest some promising possibilities for a revival and renewal of traditional building techniques using a clean, plentiful, and inexpensive material.

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