EFFICIENT BULDING CONSTRUCTIONS FROM ECOLOGOCAL MATERIALS

Olvian CAZAC

Technical University of Moldova

***Abstract*:** *Housing constructions are a anthropogenic system of protection from external climatic influences. The capacitive concept that characterizes the quality of a home is comfort which is determined by microclimatic parameters like temperature and humidity. From the point of view of comfort, clay is a natural building material which is superior in quality to other industrial building materials, but it also has main disadvantages like mold fungus which can develop within mixtures of clay and as well as a low resistance of clay building blocks to seismic activity. However, there is a solution to use clay for construction purposes by strengthening of the clay construction elements with polymer fittings which will be elaborated further on in this study.*

Keywords: *ecological housing, clay constructions, alternative construction techniques, ancient construction techniques, indoor climate*

1. Introduction

Housing constructions are a anthropogenic protection from outside weather influences. Human needs for housing construction are fully merged with the concept of quality, which involves a complex of properties that characterize the appropriateness of buildings which are used according to their functional purpose. The capacitive concept that characterizes the quality of housing is comfort, which represents a combination of factors, such as hygiene, safety and functionality. The traditional component of comfort is environmental hygiene which is determined by microclimatic parameters such as temperature, humidity, radiation to and from the surrounding objects and also the level of air pollution in a certain room.

Main exponents of microclimatic conditions are moisture and heat regime of the rooms. In moderate and cold climates, people spend about 90% of their time indoors, which motivates people's aspirations to live in a balanced and healthy indoor environment.

Quality of constructions and constructive quality of buildings has a significant impact on health and the feeling of "comfort" of dwellers. This interdependence between the quality of building and the quality of life plays an important role in modern constructions.

For the peoples' convenienceindoor climate is not only important in winter but also during hot weather - it is irrelevant whether the indoor temperature in summer reaches values of 25°C or35°C or even more . It should be also noted that the psycho-physical efficiency decreases with increasing temperature above 25 ^{0}C. When high temperatures become unbearable tihis often leads to installation of ventilation and insulation systems. Studies show that PVC windows and air conditioning affects organisms and the air in a housing construction is even more polluted than outside. Vapors emanating permanently from the paint on the walls, the floor varnish or modem furniture made from PAL and PFL which produces harmful gases,sustained between the window glasses and eventually affects human organs, likey for instance thelung or the skin and airways. Air conditioning, piped recycled dust and microorganisms can cause severe allergies, especially in sensitive individuals.

2. New systems of making art work

Researches made by Grandjean (1972) and Becker (1986) [1] have demonstrated that the relative humidity of less than 40% over a period of time mucous membrane can dry out resulting in decreased cold resistance and other related diseases. This is because normal epithelial tissue of the mucous membrane of the trachea absorbs dust, bacteria, viruses, etc., and brings them into the mouth by a wave-like motion carried by epithelial hairs. If this transport system is affected by absorption and dryness then foreign bodies can reach the lungs and cause health problems. A high relative humidity up to 70%, has many positive consequences for instance it reduces the dust content in the air, activates skin protection mechanisms against microbes, reduces the life of many bacteria and viruses as well as odors and static load from the surfaces and objects of the room. But besides its positive effects on the room itself a relative humidity of more than 70% is normally felt uncomfortable for human beings due to the reduction of oxygen in the blood in a warm and humid climate. If the air is cold and wet it may cause rheumatic aches as well. Fungi grow commonly in closed rooms where

humidity rises above 70% to 80%. Fungal spores in large quantities can cause various diseases and allergies. Based on these observations, it was concluded that the moisture in a room should be at least 40 % and less than 70%. People's desire to live in a balanced and healthy indoor environment determined the usage of modem technologies of construction of clay material in buildings. This is because clay can absorb and release moisture quickly and to a greater extent than any other building material which in turn keeps indoor climate balance.

Experiments made by the "Forschungslabor für Experimentelles Bauen" (engl.: Building Research Laboratory, or BRL) at the University of Kassel [1] shows that the first layer with a thickness of 15 cm of a clay wall mending can absorb about 300g of water per m^2 of the wall within 48 hours, if the environmental humidity suddenly rises from 50% to 80%. However, blocks of limestone and pine wood of the same thickness absorb only about 100g/m^2, plaster from 26 up to 76g/m^2. Measurements made over a period of eight years in a newly built house in Germany, with all exterior and interior walls made of clay, have shown that the relative humidity in the house was constantly 50% all year round. Fluctuations were only 5% to 10% and thereby ensuring deflected healthy conditions with low humidity in summer and high in winter. From the point of view of ensuring comfortable conditions of housing, clay is a natural building material which is superior in quality compared to other industrial building materials like concrete, brick and other artificial building materials.

Recently developed advanced techniques used for the constructions of clay demonstrate the value of not only buildings out for its own purposes, but also for industrialized constructions made by entrepreneurs. Advantages of clay to create comfortable conditions for life have caused a trend of increasingly strong emergence of clay buildings. Moreover clay houses are preferred in comparison to conventionally built houses of concrete or brick also because of considerations regarding an ecological and healthy living environment, since clay is a natural material which can be used for building purposes without strong processing.

Modem houses that have clay as main building material have a particular characteristic appearance. It can be traditional or modem, simple or sophisticated, modest or impressive. Cob building spetialist Kevin McCabe [2] has made a name for himself with his earth-houses architecture (Fig.1).

Fig. 1. New clay houses constructed cob building spetialist Kevin McCabea 1 mile from Ottery St Mary town centre unique design of houses built of clay, based on the concepts of organic architecture.

Earth Houses by Kevin McCabe is based on the interpretation of year environmentally conscious, ecological and progressive architecture. The use of clay allows him to create building shells which encompass maximum space volume with a minimum of surface area, an ideal form for energy saving purposes. McCabe's constructions avoid right angles. Their spatial diversity overcomes the monotony of standardized traditional designs. The curvy forms of the earth-houses are an ideal synthesis between form and function. The emotional form is an homage to the natural environment. The home's organic shape rolls with the landscape. But like any other building material clay has its disadvantages too. The moderate climatic conditions and high humidity, the elements of clay mixed with organic material can develop mold funguses , that can release a strong specific smell. This, in extreme cases, can cause allergies. Therefore, proper ventilation must be provided during construction so that the components of construction can dry quickly. After the walls are completely dry, which can take several months or even a year or more, depending on their thickness and climate, fungus does not produce spores. However, spore formations may recur if the water passes through the wall or from the outside through leaks or condensation inside.

A disadvantage of construction elements of clay as a building material is low resistance to seismic loads. In this context, it is noteworthy that research conducted by the Academy of Science of Moldova, after the earthquake of August 31, 1986 (measuring 7-8 on the Richter scale) have established that many constructions of clay were not affected seriously, compared to other constructions. Some buildings within 50 years have suffered for example three earthquakes and could still be exploited after they have been repaired. It turned out that in many cases, collapse of buildings during earthquakes have been caused not because of the use of clay as a building material, but rather because of faulty structural design and execution of construction works [3],

It turned out that houses that have roofs and walls light flexible due to ductility resistance structure resist to earthquakes. The quality of earthquake-resistant structures can be expressed by the formula: quality = resistance x structural ductility. This means that the lower the resistance of a given structure, the greater its flexibility must be.

The buildings are mainly struck by the throttle horizontal ridge of earth movement. Vertical accelerations created by seismic activity, represents less than 50% of the horizontal ones. The main danger during earthquakes is that the walls form cracks, which result in danger of their collapse. Therefore, one of the main structural tasks when designing earthquake-resistant buildings, is to ensure that the walls will not fall. In traditional technologies for increasing resistance to seismic actions the clay walls should be strengthened with elements of wood, steel or concrete.

The mentioned building elements have less flexibility than the clay wall. Under the action of seismic activity deformations of clay building elements will not be uniform since the deformation of the building elements will be smaller. In this case the elements will cause consolidation of clay shear walls that will cause damage to the walls (Fig. 2).

To prevent this negative effect it is proposed to implement a new method of producing clay walls, namely the use of building elements with equivalent flexibility of clay wall. The invention relates to methods of implementation of the clay walls. The method increases the seismic resistance by strengthening constructions of clay elements with a greater flexibility than the flexibility of the clay walls. The disadvantage of this method consists in the appearance of the of clay walls which lead to cutting forces which cause damage.

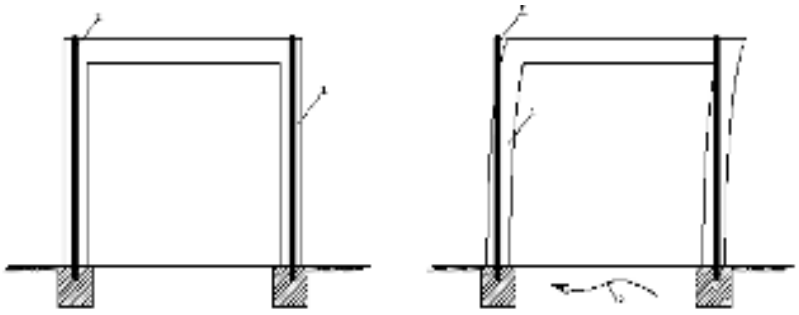

Fig.2 Constructions behavior against seismic activity:
1-bearing construction with high flexibility; 2- reinforcing elements with great flexibility; 3 - seismic action vector.

The problem, which is solved by the invention MD 615 Z2013.10.31 [4], is the strengthening of the clay wall in a horizontal position with mesh wires (strands) of polypropylene with equivalent flexibility of a clay

wall flexibility. In the vertical positioned clay walls bar it is strengthened by polypropylene bars with equivalent flexibility of clay wall flexibility. The invention is explained by figure 2, showing the implementation of the intersection of two walls of packed clay.

3. Conclusion

The result consists in obtaining a packed clay construction with high resistance to seismic actions. Therefore the main disadvantage of clay as a building material could be compensated by means of using invention MD 615 Z2013.10.31 [4] This makes clay the prefered construction material for houses that shall be longlasting accomodations by being restitent to environmental influences and which satisfy human quality and comfort standards, especially regarding microclimatic parameters like temperature and humidity. Besides ecological construction goals can be met by the utilisation of clay.

References

1. G. Minke**,** *Das neue Lechmbau-Handbuch*. Staufen, Germania, Germania (6th edition), 2004.
2. Kevin McCabe (2017): Cadhay. http://www.buildsomethingbeautiful.co.uk/project/cadhay/ (Access: 2017-11-20).
3. A. V. Drumea, N. V. Sebalin, N. N. Scladnev, S. S. Grafov, V. I. Oizerman (1990): *The Karpatsky Earthquake 1986*. Publishing Science, Kishineu.
4. O. Cazac, V. Cazac, O. Cazac, S. Sochirca (2013): *Process for the manufacture of a wall construction and wall construction.* /Patent application No.s 2012 0005/2011, MD615Z**,** 2013.10.31, Kishineu.