

## EVOLUTION OF EARTH CONSTRUCTION METHODS

### EVOLUȚIA METODELOR DE CONSTRUCȚIE CU PĂMÂNT

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**Abstract.** Human kind history bring testimonies about using earth or clay as building materials on territories of ancient civilisations. According to some populations tradition of earth building, architects and construction engineers of our days have used this common material for modern solutions of buildings or in organic composition of new materials with improved properties. The paper illustrate evolution of earth building methods and also highlighting modern constructive and architectural solutions involving this material.

**Key words:** earth building evolution, earth building methods

**Rezumat.** Istoria umanității aduce mărturii despre utilizarea pământului sau argilei drept materiale de construcție pe teritoriile unor civilizații străvechi. În conformitate cu tradiția construcțiilor de pământ prezentă la multe popoare, arhitecții și inginerii constructori din zilele noastre au utilizat acest material comun în soluții moderne de construire a clădirilor sau în alcătuirea de materiale noi ecologice cu proprietăți îmbunătățite. În lucrarea de față se relatează evoluția modalităților de a construi cu pământ, subliniind totodată soluțiile constructive și arhitecturale moderne care implică acest material.

**Cuvinte cheie:** construcții de pământ, evoluție, metode de construire cu pământ

## INTRODUCTION

Since ancient times human settlements were built using local materials, largely available in those areas, following cultural tradition and according to historical stage. The use of simple earth or in various combinations with other materials (wood and stone), is the commonly used method in houses built for thousands of years in various geographical and climatic areas. Anthropological research but also the recent years evolutions in the construction industry have highlighted the ecological potential, the sanogenous quality, but also the effectiveness in energy savings of earth as a building material, which is now being reinvented in combinations with other materials but also in terms of implementing technologies.

## MATERIAL AND METHOD

Earth architecture is one of the most powerful and expressive of human creations based on materials from the surrounding environment. This includes the most varied manifestations, both in terms of architecture and urban planning: from simple housing to stately palaces, from granaries to religious buildings, the historic

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cities centers to ancient archaeological sites. UNESCO started a program - WHEAP (World Heritage Earthen Architecture Programme), which was made an inventory of historic remains, earth buildings and architecture worldwide. In 2012 a document was drafted totaled 150 such sites involving earth architecture (fig. 1, fig. 2, fig. 3, fig. 4, fig. 5, fig. 6) (World Heritage, 2012)

Building techniques for earth edifices are known for over 9000 years, houses dating from 8000-6000 BC land Turkistanull being discovered in Russian (Pumpelly, 1908) (Minke, 2008). The earth was used in all ancient cultures, not just for building houses but alsow religious and representation buildings (fig.1).



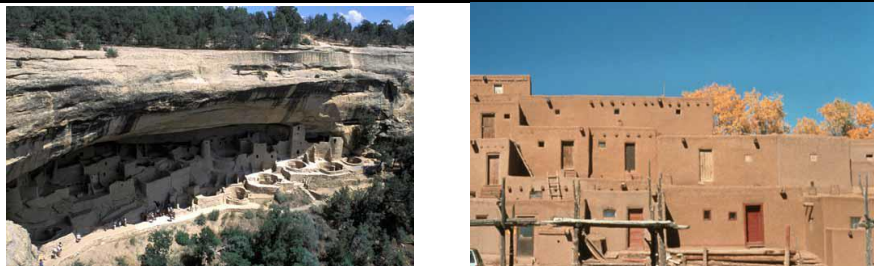
**Fig. 1** The images of Funerary temple of Ramesses II, 1200 BC. Thebes Necropolis, Egipt (left), Old city of Ashur, Iraq, the ziggurat and the great temple of the god Ashur, III milenium-II BC, (right) (World Heritage, 2012)



**Fig. 2** Old Towns of Djenné, Mali, Africa, III century BC (World Heritage, 2012)



**Fig. 3** Fortified medieval town of Provence, France, IX-XXI century (World Heritage, 2012)



**Fig. 4** Mesa Verde National Park, USA, X-XXI century (left), Pueblo de Taos, Arizona and New Mexico, USA, XI-XV century (right) (World Heritage, 2012)



**Fig. 5** Old Walled City of Shibam, Yemen, XVI century (left), The Mausoleum of Oljaytu, Iran, XIII-XVII century (right) (World Heritage, 2012)



**Fig. 6** Himeji-Jo Castel, Japan, XVII century (left). Fujian Tulou, China, XV-XX century (right) (World Heritage, 2012)

Earth as a building material can be scientifically called "clay" and is actually a mix of clay, fine sand (sludge), sand and possibly coarser components such as pebbles or stones. It can be used in several forms: "clay bricks" or "adobe" for unburned earth bricks, compressed earth uses the term "earth blocks" and when the earth is compacted in a mold, it is called "rammed earth". Also used, earth lumps mixed with straw, can be used as such or can be built on a trellis, between two such networks of twigs or on slats of wood, with a clay plaster on the outside.

Compared to standard industrialized building materials, clay has both advantages and disadvantages (World Heritage, 2012).

Among the disadvantages we can mention:

- clay material is not standardized (based on place of origin it can have different compositions and properties);
- mixture of clay shrinks when it dries, causing cracking of this construction;
- clay is not waterproof, it should be protected from rain and frost especially if it is wet (by covering the walls with roofs with wide eaves, or a layer of moisture-resistant masonry, or other layers of protection).

Instead, clay has many advantages that industrial materials do not have:

- clay balances humidity (can absorb and release moisture faster and to a greater extent than any other building material);
- clay keep the heat due to large thermal inertia balancing indoor climate where there are large temperature differences between day and night;
- clay saves energy and reduces pollution of the environment;
- clay is reusable by soaking with water;
- clay reduces costs for materials and transportation;
- ideal for constructions made in with local labor force;
- helps preserve the wood and other organic material embedded in it;
- clay absorbs pollutants.

## RESULTS AND DISCUSSIONS

Coming from Canada, in 2004, romanian architect Ileana Mavrodin, built a experimental clay lodge in Sasca village, Caras Severin, subsequently, moved permanently, and today is often visited by tourists curious to see a bio house, perfectly integrated into the landscape (<http://agointel.ro>).



**Fig.7** Bio House, Sasca, Caras Severin, Romania (<http://agointel.ro>)

Michael Reynolds is one of the American architects who implemented the concept of Biotope, building especially in New Mexico, USA, sustainable and energy independent houses, incorporating recycled materials (tires, aluminum cans, plastic bottles, colored bottles, etc.), all filled or embedded in compacted earth. These homes accumulate sun's heat in summer within the thick walls and use it in winter. Rainwater is also collected and integrated it into 4 cycles of use, household waste being processed into fertilizer for greenhouse plants grown in winter (fig. 8) (<http://agointel.ro>, <https://earthshipstore.com>, <http://www.greenhomebuilding.com>).



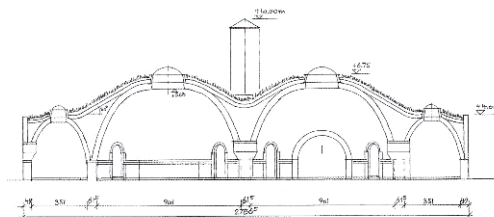


**Fig.8.** Images of Michael Reynolds houses  
 (<https://earthshipstore.com>, <http://www.greenhomebuilding.com>,  
<http://www.tboake.com/earth.html>)

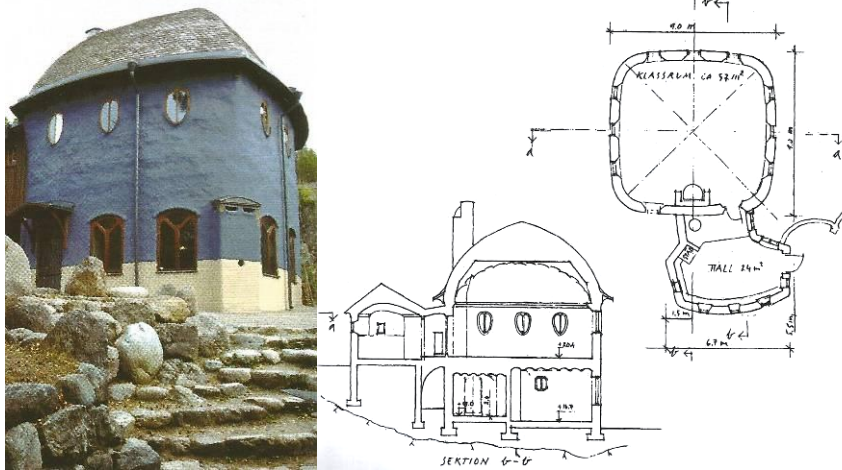
Another way of building with earth is filling plastic bags or jute bags with soil or sandy loam and then building that into a wall covered with earth plaster or whitewash (for jute preservation). Californian architect Nadir Khalili took further the idea, using continuous tubes made of jute bags filled with earth and built a house in Brazil in this constructive system (fig. 9) (World Heritage, 2012).



**Fig. 9** House built from continue raffia tubes filled with earth, Brazil  
 (World Heritage, 2012)



**Fig. 10** Mosque with two domes, built entirely of unfired clay blocks covered with earth and grass SII, arch. Gernot Minke, Wabern, Germany, 2007 (World Heritage, 2012)



**Fig. 11** Waldorf School built with blocks of solid clay, arch. Mats Wedberg, Jarna, Sweden, 1993 (World Heritage, 2012)

Although earth construction are rather suitable for warm or temperate climates, in the world were built even in cold areas (fig. 10, fig. 11). Lately appeared more and more buildings using beaten earth or unburned clay bricks, in combination with wood or straw, as recognition of the respect for nature. The high energy consumption and huge transport costs, construction and maintenance emplied by modern materials, generates an awernes regarding pollution and natural resources consumption.

## CONCLUSIONS

Earth buildings where always a handy and easy way to put into practice a building sistem. Nowadays, the clay advantages, that other industrial materials do not have, encompass a higher consciousness on the environment.

Earth construction methods, put into practice and combined with other materials, generate today many sustainable buildings and high energy efficiency.

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