# EARTHEN ARCHITECTURE – REGIONAL CULTURAL HERITAGE


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## Summary

Unburnt clay – a natural building material – is more than simply a renewable resource or wasteless technology. Inside buildings it creates a healthy living environment. Earthen buildings represent a regional cultural heritage which is gaining importance in today's globalized world. Nevertheless, public awareness of historical earthen buildings is very low as is awareness of the possibility of their reconstruction or the use of earthen technology in new buildings.

The Earthen Architecture Association in cooperation with the Faculty of Architecture of the Brno University of Technology, within the framework of the project INTERREG IIIA, investigated four villages in the Vyškov region, where the extent of the use of earthen materials in existing buildings was assessed. The reconstruction of one such building was used to document the feasibility of the environmentally friendly reconstruction of earthen structures.

**Keywords:** Clay, earthen material, regional architecture, preservation, natural building material, healthy houses

## 1 Introduction

Building materials used in the past for construction originated mostly from local natural resources. The external appearance of objects, their volume, proportions, roof inclination and façade articulation were affected by site character, by diverse topographic, climatic, economic and historical conditions which mirrored in basic construction techniques. In rural areas the method of home building passed from generation to generation and gave rise to different regional styles of folk architecture.

The contemporary globalized world of multi-purpose digital architecture puts once again a great emphasis on the legacy of regional architecture and on the use of local natural materials that are most environment-friendly of all building materials, easily recyclable and relatively cheap.

South Moravia is a region with the traditional folk architecture of earth buildings. Zones of historical monuments have been decreed in villages with the preserved complexes of folk architecture and a lot of structures have been listed for monument preservation.

In spite of all efforts on the part of the care of historical monuments to preserve the original architectonic culture and its historical value, the reconstruction of listed structures built of raw clay is problematic and many historical monuments are immediately endangered. The reason is a lack of these building materials on the market and namely an absent expertise of ordinary construction companies in using the materials. Although the raw clay was in the past the most frequently used building material in South Moravia, the traditional procedures of building structures from unburnt clay have been forgotten and their revival has come only now.

The Association of Clay Builders wants to contribute to the improvement of this situation not only in the conservation of folk earth buildings as a national cultural heritage but also in the reconstruction of existing objects built of raw clay including the use of this material in the construction of modern objects. The re-discovered raw clay capitalized by high-quality processing and rational design may play an important role in the contemporary architecture as building material.

Regarding the fact that raw clay has been gaining ground in the building industries of West European countries thanks to its properties unobjectionable to human health, it is necessary that expert and general public is properly informed of its benefits.

An international conference on NATURAL MATERIALS IN STRUCTURES was held on 15 June 2006 within the framework of the project INTERREG IIIA CR-SR "Through foretimes to the future – Natural materials in the regional building culture", at which prominent and highly skilled foreign and Czech experts presented their recent experience from the reconstruction of old earth buildings and from the building of new low-energy structures based on natural renewable materials and informed the conference participants of the latest trends in modern and environment-friendly housing development.

The next stage of project implementation included surveys on the occurrence of natural materials in the existing architectural structure of the Větrník group of municipalities made by students from the Faculty of Architecture, Technical University Brno. The research showed that dwelling houses, barns and enclosure walls were nearly as a rule built of clay material. From the second half of the 19th century when the price of burnt bricks dramatically fell down due to the invention of circular kiln, these were gradually gaining ground and fully replaced cobs thanks to the promotion by brick making industry. The research also demonstrated that most earth houses not enlisted under the care of historical monuments have street façades with decorative (scraped) lime-cement renderings. A different situation can be seen in yard façades which have been many a time left in their original clay form and which are often in poor condition.

Moreover, some objects were suggested for environment-friendly tourist activities after refurbishment or reconstruction to demonstrate that relations to local resources and traditions can help in the economic stabilization of the microregion. Last but not least, a lesson from the traditional building culture may contribute to inspiration in the creation of new rural developments.

Therefore a part of the project whose bearer is the municipality of Rostěnice is the preparation of a building plan for the reconstruction of an old earth house with half-storey that has been unused and devastated for some time. In the object’s yard there will be a new annex situated in place of the existing tract of farm buildings. The reconstruction with the addition is to serve as a reference example of the ecological structure built of natural

materials in energy-saving standard for reconstruction and in passive standard for the new section. The object will be used as a public structure with a possibility of accommodation fulfilling the function of a tourist information centre and a centre of ecological activities.

**Fig. 1** Street view of the existing unused object in village square structure

**Fig. 2** Yard view of devastated farm buildings

Preparatory works started with a static research of the object, which included a survey of the foundation structures, walls, ceilings and roofs of the main object and farm buildings in the yard. The subsequent microbiological inquiry was focused on clay brickwork surface. Disrepair of the farm buildings in the yard and of the current roofing was stated already during the first inspection. Borrow pits in the foundation structures showed that the basement is an approx. 0.4-0.5 m high strip foundation of stonework embedded in stone packing filled with loose clay, which hardly reaches the width of object walls. Ground water was found in a pit at the front wall at a depth of 0.8 m under terrain surface; groundwater table in the yard is ca. 1 m under terrain surface. Water-bearing loam under foundations has an insufficient carrying capacity both for the existing object and for the object after reconstruction.

The material of walls was studied by samplers which revealed that the clay walls are demarcating the space of apparently historically oldest street tract while the yard extension is already built of fully burnt bricks, similarly as the front wall of the object and the farm buildings. All masonwork is affected by ground damp rising up to 0.5 m. The masonry was studied for strength, dampness and activation by moulds.

**Fig. 3** Pit in the basement

**Fig. 4** Taking samples from the wall

Strength of the clay masonwork was determined in non-destructive tests by using Schmidt PT impact hammer and verified in the press on cob bricks taken out from the brickwork. Measured strength values differed. While the results of non-destructive tests by impact hammer showed values ranging from 4.40-6.70 MPa, the destructive method determined the individual compression strengths on moulded bricks withdrawn from the masonwork as ranging within an interval from 2.2-4.4 MPa. The resulting classification is a guaranteed compression strength of brickwork at 3.00 MPa. Reasons for the different values of compression strength are not seen in the material which does not differ either in material composition or in moisture condition but they rather consist in the different form of tested material, i.e. in sample size and preparation. The non-destructive tests were made in the compact masonwork from which only plaster coat was removed and it was otherwise not subjected to any mechanical load. The destructive tests were carried out on individual samples of building elements taken from the masonry. Removal from the masonwork had to be made by a mechanical procedure – by cutting out individual moulded bricks – in which some of the moulded bricks were slightly affected.

**Fig. 5** Testing the strength of bricks by Schmidt PT impact hammer

**Fig. 6** Bricks removed for strength test in the press

**Fig. 7** Test of dampness


**Fig. 8** Microbiological analysis (colonies of *Penicillium* moulds)

Moisture content was determined on a part of the taken samples by gravitation method. The samples were dried in a temperature controlled laboratory drier to stabilized weight at a temperature of 105 °C. Moisture content was determined as absolute – $W_A$, i.e. weight difference before and after desiccation was related to weight after desiccation, ranging from 2.43-4,20 %; mean values were concentrated in a range from 3.30-3.56 %. These

measurements indicated that the moisture content of moulded bricks in the entire volume of masonwork above the level of the wet bottom part is relatively low and stabilized.

The microbiological analysis was made on samples taken out from the brickwork, which were subjected to microbiological check based on the cultivation on solid cultivating medium in aerobic conditions at a temperature of 25 °C in the temperature-controlled oven on Petri dishes. The samples were applied onto the cultivating medium directly after crushing and then in the form of aqueous extract. Results following out from the microbiological microscopic examination show that samples presented for the analysis contained moulds after cultivation, presumably of *Penillium* genus. They were therefore considered positive with respect to the microbiological environment with their growth and reproduction being conditioned by the presence of humidity, suitable temperature and oxygen. Their growing on the clay material surface can be prevented by the removal of the original finish and by the application of a new finish coat.

Ceiling construction above the first ground storey of the main object consists of half balks with reed lathing, the scantlings being at a different stage of damage. Static assessment of the ceiling which did not take into account the damage to wood revealed an unsatisfactory carrying capacity of individual common joists in the ceiling; this is why their bracing will be suggested in the project.

The existing object will be reconstructed in compliance with the conditions stipulated for the zone of historical monuments with an aim to preserve the original architectonic segmentation and appearance of the street façade and the original height of roof crest. The reconstruction is to make a maximum of using natural building materials.

**Fig. 9** Proposal for the façade reconstruction and design

The yard façade of the object has already a new face reflecting the internal house disposition. The main goal for a new architectonic and disposition solution of the new object is to design a low-cost, simple and purposeful structure of environment-friendly materials with low operating costs, flexible disposition and low energy requirements with using passive solar gains.

The new work construction is designed as a timber framework with the thermal insulation filling of straw and with the indoor earth liming. Roofing will consist of nailed timber trusses with thermal blown insulation made of Climatizer Plus cellulose.

**Fig. 10** Proposal of new work in the yard

Spatial rigidity of the timber framework will be assured by reinforcing wall and ceiling constructions with moisture-proof OSB boards which are to fulfil the function of vapour-tight barrier in addition to bracing the object. With respect to the fact that the new work is designed in the parameters of passive house, it is necessary to eliminate thermal bridges in the foundations, to ensure as good as possible thermal insulation parameters of all elements of envelope, roof, floor, windows and doors, and to reach the required air-proofness. The new work will be heated by a warm-air heating system with controlled ventilation and heat recuperation. Heat source will be electric boiler which is to be used also for hot service water preparation. An additional source in the basic system of heating will be a low output fire stove. The reconstructed object which is designed as a low-energy house will be equipped with a controlled low-temperature heating system (gas heating with radiators). The source of heat will be condensation gas boiler which is to be also used for hot service water preparation.

The project's objective is to create a healthy and pleasant environment which would serve both citizens living in Větrník and visitors to the Větrník microregion. The yard coming to existence between the existing object under reconstruction and the new work will create an atrium – a space where the foretimes meet the present in order to address the future.

*The research was cofinanced from the following projects:*
*a) INTERREG IIIA Czech Republic – Slovak Republic „Through foretimes to the future – Natural materials in the regional bulding culture" Project no. in MONIT: CZ.04.4.84/1.2.00.1/0216*
*b) OP RLZ "Clay today – Natural materials and unburnt clay in modern and traditional structures", Project registration no.: CZ.04.1.03/3.3.11/3131*

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