The Effect of Moisture in Wooden House from Natural Materials

LUCIE KUCEROVA, SARKA KORBELOVA
Faculty of Civil Engineering
VSB-Technical University of Ostrava
Ludvika Podeste 17, 708 33 Ostrava Poruba
CZECH REPUBLIC
lucie.kucerova@vsb.cz    sarka.korbelova@vsb.cz    http://www.vsb.cz

Abstract: - One of the major sources which may negatively affect the natural materials is the moisture. Its negative impacts may occur both in the construction of wooden houses, as well as on its surface. Especially if due to poor design or implementation the water vapor condenses inside. For detection of temperature and humidity in the construction of floors and walls, and their potential impact on the stability of the entire building, the reference construction in the village of Kramolna was selected, in which the temperature and humidity sensors were installed. Based on the evaluation of the data obtained, the actual behavior of wooden house will be able to evaluate.

Key-Words: - Wooden house, timber construction, moisture, natural materials, humidity.

1 Introduction
The construction industry is currently facing new demands and trends which in the recent past were not the key points of construction. These trends fall within the scope of ecological construction, sustainable construction and consumption of energy. All these areas have factors that are connected to one another. These factors are finance and exhaustible sources of energy. From this perspective, the emphasis is on the use of such materials, technologies and structures that meet the requirements of quality and functionality, as well as environmental requirements.

In the construction sector there is growing increase of the use of materials that are different from today's modern materials. It could be called as alternative materials for construction. Whether these materials are called no matter how, the fact remains that their use is no news. Natural materials such as wood, straw, clay or sheep's wool has been used in construction since time immemorial [5]. Rather, one could say that they have been re-discovered. With the development of technology there are also various modifications of natural materials. The aim is to create a structure of materials whose properties would meet all quality requirements and also would be fully recyclable with low cost.

2 The Natural Materials
The parts of plants are traditionally used in the building industry. Shelter braided from grasses was one of the first structures, moss pads used in timbered buildings, and clay plaster and clay bricks are traditional building technologies. "Thermal insulation" of rural building by storing of hay and straw in the attics during the winter season is the first example of building insulation.

There are many other materials applied in construction which use wooden mass as a source of primary raw material. One of the most important products is the cellulose and products thereof. Another excellent thermal and acoustic insulator is sheep's wool, slabs of hemp and various fibreboard. The reason for their use in the construction industry is to reduce the negative environmental impact of the construction by use of more renewable sources.

In terms of the principles of sustainable development, it is necessary to perceive a positive impact on other segments of human activity, eg. The management of cultural landscapes, new incentives for agricultural production, local material and human resources etc. The use of such materials and products in modern designs has its own specifics. It is always necessary to work with these materials on the basis of their technical properties, declared by the manufacturer or processor. On this basis, it is necessary to carefully and responsibly consider the possibility to use specific benefits and risks in a given context. Responsible design proposal must follow which accepts all the structural context of a specific construction detail. It is also important to check the implementation in situ [4].
Presented examples of materials and products from renewable sources indicate the possibility and potential for wider application. Numerous examples is currently in the plane of experimental technology which in comparison with the conventional methods exhibits a increased labor input, a low speed of construction and large demands on manpower. A prerequisite for their more widespread in modern building structures is to ensure a constant quality of the mechanical and physical properties, efficiency of technological processing and wide availability, which may be provided by the industrial processing of these materials. At present, these materials and technologies already able to compete with commonly used materials and help reduce the impact of construction on the environment. In the future, may be an effective technologies using renewable natural resources belong to significant technological alternatives and help to improve the quality of construction in the context of sustainable development.

3 The Moisture in the Wooden Houses

Wood is a natural material with all the positive as well as negative characteristics. Wood continuously adapts its moisture state to the environment in which it is placed. A change of the moisture of the wood is accompanied by a change of its dimensions. Humidity of environment influences the dimensional stability of wood products and strength of adhesives used in the manufacture of composite materials based on wood. Therefore it is important to control the amounts of moisture in the structure.

The humidity can seriously affect the life and proper functioning of wooden building. Due to bad effect of moisture on the structure may not always be immediately visible on the surface of the structure. There is a condensation of water vapor inside the structure very often. Most of the supporting elements of the wooden house are from wood or wood-based materials, so the moisture in the structure in the long run can affect the stability of the whole construction. The effect of moisture on thermal layer in the structure is also significant because it can cause a reduction of the thermal properties, or even the degradation of entire insulating layer.

3.1 The Causes of Moisture in Wooden House

Larger leaks of fluids in most cases can be detected almost immediately, while the small ones are usually detected until later. They may therefore cause more damage. The causes of increased humidity may be several:

- Errors resulting from the implementation or operation of the construction (construction mistakes).
- Errors caused by poor design of wooden house (design mistakes).
- Failures of the pipeline in the construction (cracked or leaking pipes).
- Accidents caused by user (leaking washing machine).

3.2 The Consequences of Moisture in Wooden House

Problems that may be caused by increased humidity:

- Condensation of water vapor on the surface of the structure.
- Condensation inside the structure (deterioration of the properties of materials in the construction).
- The occurrence of mold (inside the structure, the surface of structure).
- Degradation of natural materials in the construction (fungi, pests)

4 The Reference Wooden House

The building is located in the village of Kramolna, near the town of Nachod in Czech Republic. The house is one-storey wooden house with a saddle roof. It is based on concrete footings with airgap between the floor and ground (Fig. 1). The supporting structure is made of oak squared timbers (Fig. 2). The floors, walls and roof are made of a beam STEICO, 300 mm thick and OSB boards (Fig. 3). The thermal insulation of the building consists of blown insulation Climatizer PLUS. Doors and windows with triple glazing are made of plastic. The facade is partially clad with timber cladding and clay plaster which is also used in the interior.

Fig.1- The reference wooden house.
4 The Methods of Measurement

In terms of creating the most accurate image of amount of humidity in the building it is important to do the long-term monitoring of moisture in most critical points of wooden building (inside of the structure). This makes it possible to detect the increase of moisture due to an accident in the construction or to uncover some structural defects in the wood construction. The construction is also exposed to seasonal influences (temperature, humidity) which affects the value of the measured values. It is also one of the main reasons why it is not appropriate the sampling carried out only by random [6].

The verification of the correctness of the structural design and construction details of wooden house (Fig. 4) will be done by long-term monitoring and subsequent evaluation of selected thermal and technical parameters. The sensor were installed in the wooden house (Fig. 5).

The sensors will record temperature and relative humidity inside each construction of the wooden house. Other sensors will record the boundary conditions in the interior and exterior of the building. The arrangement and location of sensors allow the evaluation of the thermal insulation properties in detail of the building.

5 The Evaluation of Measurement

5.1 Critical details

When evaluating the structures from the area of Nachod the boundary condition will be $\theta_e = -17^\circ\text{C}$ for outside air temperature and $\theta_{ai} = 20^\circ\text{C}$ for indoor air temperature [2]. The resistance to heat transfer inside the building structure according to CSN 13 788 (2002) [1] specify a value of $R_{si}=0,25 \text{ m}^2\text{K}/\text{W}$ which corresponds to the slower air flow in a corner or behind furniture. The transfer resistance at the temperature on the outside of $R_{se}=0,04 \text{ m}^2\text{K}/\text{W}$ is valid for outdoor use.

The simulation of the temperature and the condensation of water vapor was made in solved details by using software Area 2011 (Fig. 6,7).
6 Conclusion

The aim was to introduce a summary of the basic facts and properties often overlooked variables that can very negatively affect a wooden building. The solution of an individual display of moisture depends on the specific case and especially on the degree of damage. The important thing is to count with the possible occurrence of moisture already during the design of wooden house and to pay attention to the construction technology already in the construction phase. In particular, there should not be forgotten the monitoring of critical details in timber house, such as the connection of the structures at each other.

Acknowledgement:
This paper was supported by Student grant competition „SP2015/164- Thermal technical and humidity issues of wooden buildings with crawl space.

References: