Course of Temperatures in Construction of Wooden House

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Abstract. The course of temperatures in the construction is one of the main indicators of well- designed and implemented wooden buildings. And improper design may cause the penetration of cold outside air into the structure which may negatively affect the whole construction of wooden house. This article focuses on selected construction of three wooden buildings which were carried out the in situ measurements. The resulting values are then compared and evaluated in terms of impact on the construction of wooden house. Mentioned are also possible and potential repairs and preventive measures.

1 Introduction

Wooden buildings are among the basic types of structures for the building of buildings. Over the years, this type of construction was somewhat neglected. However, in recent years, the construction of wooden buildings begins to expand more and more. With the development of modern technology, there is a revival of wooden buildings as structures for building houses. Wooden buildings are getting back into the awareness of people who choose it as an option of construction.

The market offers more and more companies that are concerned with the construction of wooden buildings. The considerable share in the development of wooden buildings is an effort to save funds relating to the costs of running the house.

The last few years there is a change of material which is used as a thermal insulator. In recent years, it was used mainly polystyrene and mineral wool. Currently people return to natural materials such as straw, wool, cellulose, and fibreboard. Such as plaster are used clay plasters which allow the escape of moisture from the construction [1]. Based on these new trends, the new composition of exterior walls arise. All of these trends in the construction industry are pushed to improvement by rising energy prices and strict thermal technical requirements.

This article shows the condition of the timber buildings specifically the building envelope in terms of the course of temperatures in construction of wooden house. Therefore, the measurements were taken on the selected timber houses and subsequent evaluated whether the envelope construction of the designed wooden buildings meet current thermal requirements of technical standards [2].

2 Cladding of the Wooden Houses

It is interesting to follow the historical development of the envelope of wooden houses. The oldest designs of the wooden buildings are the log cabins. Even today, this type of construction is still built, but the innovations were brought to construction [3].

Do wooden prefabrication also been introduced. This method of construction has many positives such as speed of construction, quality control implementation. The disadvantage is transportation to the construction site [4].

A widespread type wooden buildings are frame wooden buildings. This type of wooden buildings is assembled directly on site. Wooden supporting elements form the support construction and there is placed a thermal insulation between the supporting elements. For these structures the quality of a work as a whole is an important. For these structures is an important quality of a work as a whole. Wooden elements of the structure consists of a thermal bridges, which has to be well insulated to not impair the quality of construction.

3 Description of the Reference Wooden House

3.1 Wooden House A

The measurement was carried out on 5-year-old single level family house (Fig. 1), located in the village of Hodslavice and is designed as a timber frame. The envelope wall (Fig. 2) consists of a diffusion-sealed structure in which there is a vapor barrier. The supporting structure is made up of columns of 80/160 mm RD C 24 in the axial distance of 600 mm, which are on both sides sheathed OSB boards 3. The thermal insulation function serve mineral insulation between the vertical columns and exterior insulation system.

Figure 1. Measured timber house A.

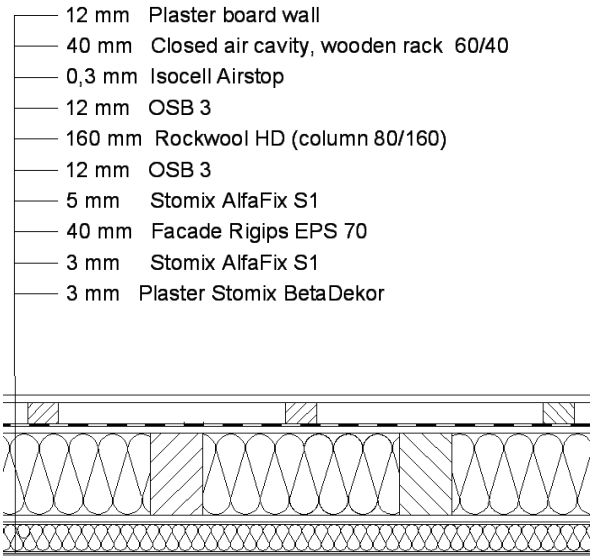

Figure 2. The envelope structure of the timber house A.

3.2 Wooden House B

The building is located in the village Kramolna, near the town of Nachod. The house is one-storey wooden house with a saddle roof (Fig. 3). It is based on concrete footings with airgap between the floor and ground The supporting structure is made of oak squared timbers. The floors, walls and roof are made of a beam STEICO, 300 mm thick and OSB boards. 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. 4). The measurement was made in the part of the building with the clay plaster.

Figure 3. Measured timber house B.

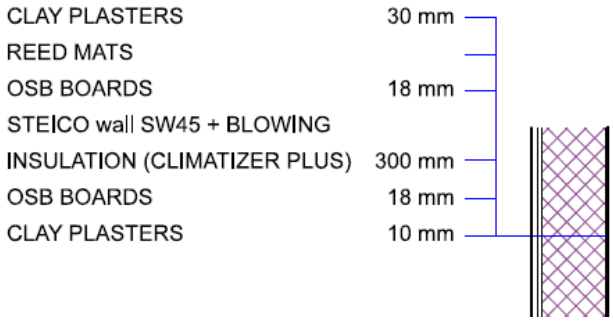

Figure 4. The envelope structure of the timber house B.

3.3 Wooden House C

The house is located in the village Markvartovice in Moravian- Slesian region. The house is two- storey wooden house with a saddle roof (Fig. 5) The envelope wall is diffusion-closed with a vapor barrier. The supporting constraction is consist of columns 60/160 mm (KWH) in the axial distance 650 mm. The thermal insulation of the building is Isover Rio (160 mm) and facades polystyren (70 mm) (Fig. 6).

Figure 5. Measured timber house C.

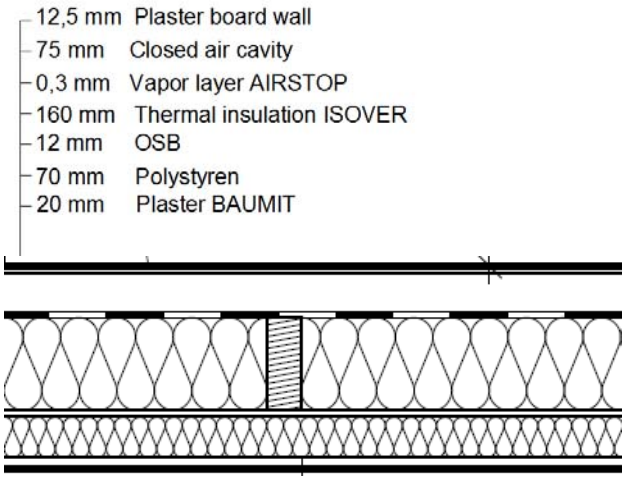

Figure 6. The envelope structure of the timber house C.

4 Measurements

Measurements were carried out during the winter months when the outside air temperature was below freezing. At this period, the difference of internal and external temperatures is maximal, and is also perfect for monitoring temperatures in the structure.

The verification of the correctness of the structural design and construction details of wooden house was done by monitoring and subsequent evaluation of selected thermal and technical parameters.

The 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 (Fig. 7,8).

Figure 7. The location of the sensors in the construction.

Figure 8. The location of the sensors in the construction.

4.1 Computer software

The boundary conditions which include temperature, relative humidity, and resistance to heat transfer at the interface of environment has to be included to the calculation. Without the difference in temperature the heat transfer would not happen. The boundary conditions of the temperature were used the averaged values which were measured in situ. θ_e= -15°C for outside air temperature and θ_{ai}= 21 °C for indoor air temperature. The resistance to heat transfer inside the building structure according to [5] specify a value of R_{si}=0,25 m^2K/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 m^2K/W is valid for outdoor use.

The measured values of boundary conditions were used for the simulation of the calculation models. The results of the course of temperatures in the external walls are shown in the picture below (Fig. 9,10,11).

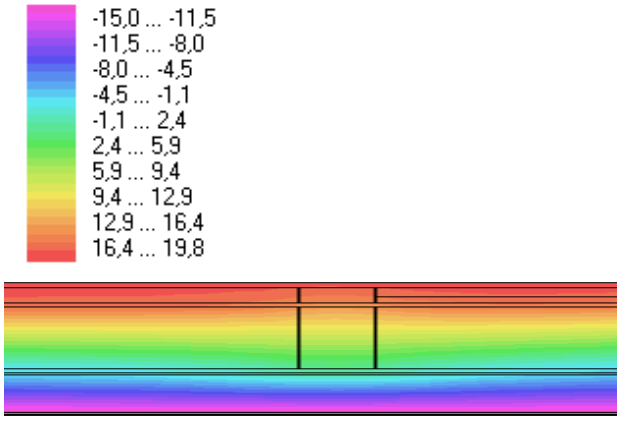

Figure 9. Output of Program Area 2011 - temperature field (Wooden house A) [6].

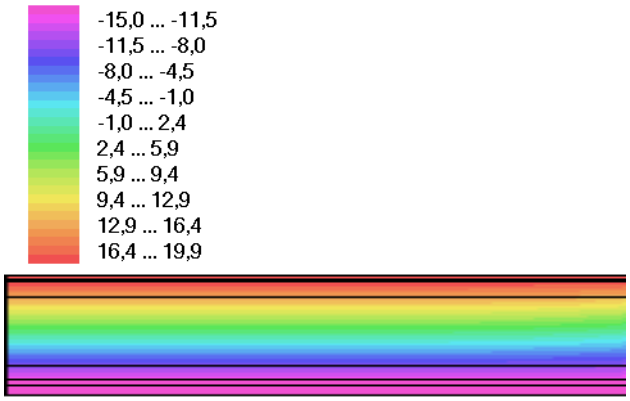

Figure 10. Output of Program Area 2011 - temperature field (Wooden house B) [6].

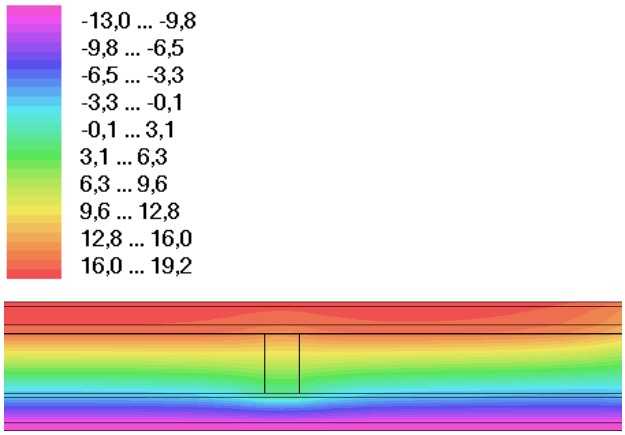

Figure 11. Output of Program Area 2011 - temperature field (Wooden house C) [6].

5 Summary

The course of temperatures in construction varies depending on the season. This causes temperature variations in the structure. Unstable thermal environment causes stress to the structural elements, and causes the degradation of other layers in the structure. Researched

wooden buildings have sufficient thermal insulation layer, therefore stress of the structure is not so significant and generally prolongs the life of wooden structures.

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References

[1] J. Chybik, Prirodni stavebni materialy, Grada, Praha, **12** (2009)
[2] J. Vaverka, Drevostavby pro bydleni. 1. ed., Grada, Praha, **25** (2008)
[3] J. Teslik et al., 2013, Advanced Materials Research, Volumes 860-863, Airtightness and acoustic properties of family house from straw,**1215-1218** (2013)
[4] CSN 730540-2 Thermal protection of buildings - Part 2: Requirements. Praha: Cesky normalizacni institut, (2011)
[5] L. Kucerova, M. Cernikova, B. Hruba, Aplied Mechanics and Materials, Volumes 470, Thermal technical assessment of selected construction of wooden houses, **988-991** ,(2014)
[6] Z. Svoboda, TEPLO 2011 pro Windows. Calculation program for PC.