EXPERIMENTAL EXAMINATION OF ENERGY AND MICRO-CLIMATE PROPERTIES IN TWO LOW-ENERGY BUILDINGS

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Summary

In the frame of UNDP and GEF project **"Low-Energy and Low-Cost Dwelling House for Czech Republic"** two large apartment houses were carried-out. Their low-energy standard had to be demonstrated by experimental examination. The results of internal microclimate and energy consumption monitoring of these two buildings are described in the following paper.

Keywords: Low-energy and low-cost building project, energy consumption, internal microclimate, experimental examination, ventilation system, heat recovery

1 Introduction

In 2007 the project **"Low-Energy and Low-Cost Dwelling House for Czech Republic"** supported by United Nations Development Program (UNDP) and Global Environmental Facilities (GEF) was finished. The main aim of the project was to stimulate construction of low-energy houses on Czech Republic territory. Faculty of Civil Engineering and Faculty of Architecture Czech Technical University, Environmental Centrum of Charles University and Energy Efficiency Centrum Prague were collaborated on this project.

There were two main parameters, characterising low-energy and low-cost building in this project:

- maximum annual energy consumption $e_a = 50$ kWh /m^2 a
- maximum investment price 610,-€ / m^2 of heated area.

As the result of the project, two large apartment houses and several family houses with low-energy standard and common invest expense were constructed. One of the project tasks was to demonstrate low-energy properties of realised buildings by experimental examination of their energy consumption.

2 Apartment House in Sušice

2.1 Description of building

The first building, erected in the frame of the project, was apartment house in small South Bohemia town Sušice. The three-floors building with transversal system of bearing walls consists of nine flats and its appearance is typical for classical low-energy buildings – main facade with maximal window openings faced to south and north facade with minimal area of windows. In the plan of the building the individual temperature zones are very strictly observed.

The basic building physics data of the building are following:

- cladding $U = 0{,}2$ W/m^{2}K,
- flat roof structure $U = 0{,}2$ W/m^{2}K,
- double glassed windows $U = 1{,}0$ W/m^{2}K,
- calculated annual heat consumption $e_a = 55{,}0$ kWh / m^{2}a.

The building is heated with the help of central gas boiler, space heaters with thermostatic valves and individually controlled ventilation system with heat recovery are used.

The cost of 1 m^2 of heated area the completed building is 550 €. This final price is calculated without price of lot.

2.2 The results of internal microclimate and heat consumption monitoring

In experimental examination the following parameters were measured:

- external air temperature and relative humidity,
- internal air temperature and relative humidity (in flats A2, B1, C3)
- flat energy consumption (in all flats)
- gas consumption (in boiler room)

Dataloggers Logger S 3120 with time interval 15 minutes for measuring of air temperature and humidity plus built-in energy consumption meters (in all flats) were used.

The course of temperature of internal air in typical flat (**Fig. 1**) and very atypical course of temperature in another flat (**Fig. 2**) in heating period are seen on following diagrams.

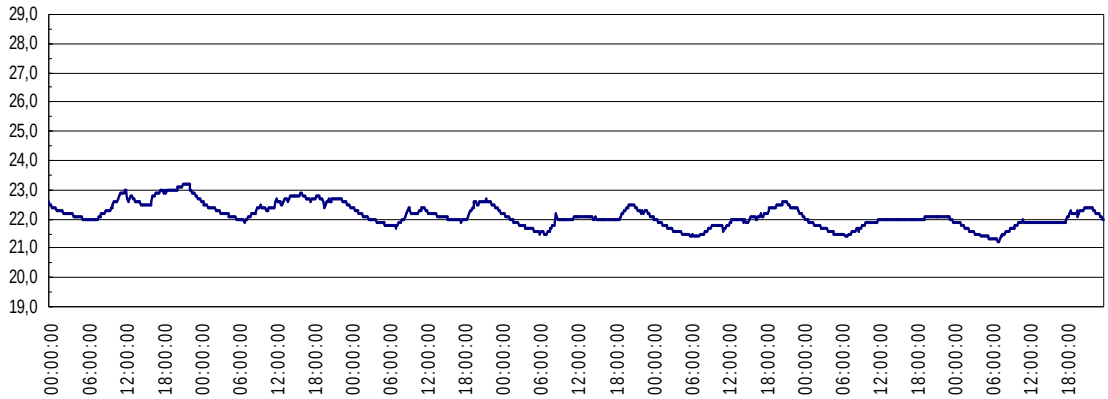

Fig. 1 Course of internal air temperature – flat C3, period 29. 11.-05. 12.

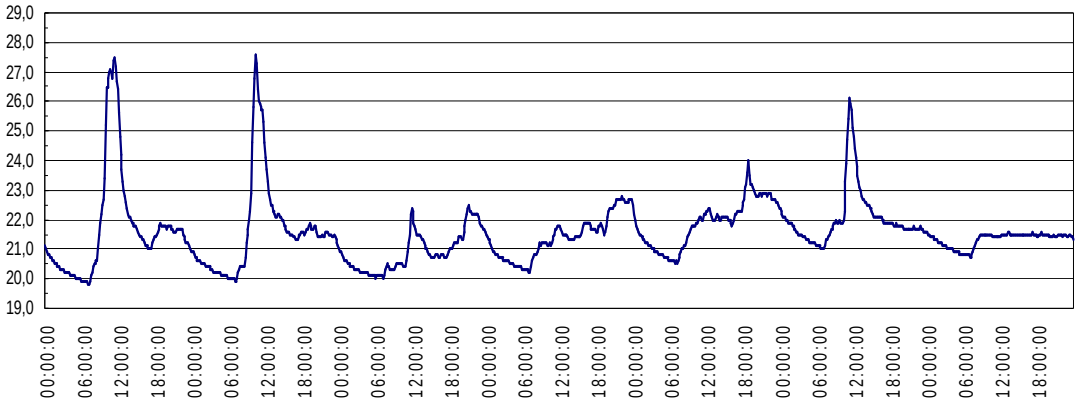

Fig. 2 Course of internal air temperature – flat A2, period 20. 12.-26. 12.

In summer period the course of internal air temperature and humidity is in all flats uniform.

Real building annual consumption of energy, gained as a result of heat consumption monitoring is e_a = 42.0 kWh / m^2a.

3 Apartment House in Železný Brod

3.1 Description of building

The building is situated in central part of the North Bohemian town with very non-standard on-the-site orientation. The bearing system of building is formed by transversal bearing walls and monolithic reinforced concrete ceiling slabs.

Central heating system with condensation gas boiler, situated on the roof, is used. 24 roof solar collectors with 500 litres storage bin are used for pre-heating of domestic hot water.

Building physics data of individual structures:

- cladding U = 0,12 W / m^2K,
- flat roof structure U = 0,10 W / m^2K
- double glassed windows U = 1,30 W / m^2K
- calculated annual energy consumption e_a = 45,6 kWh / m^2 a

Final cost: 550 € per m^2 of heated area.

3.2 The results of internal microclimate and heat consumption monitoring

During experimental examination of this building the following parameters were measured:

- external air temperature and relative humidity,
- internal air temperature and relative humidity (in three flats),
- gas consumption (in boiler room).

For measuring of air temperature and humidity dataloggers Logger S 3120 with time interval 15 minutes were used.

Both in summer and winter period courses of internal air temperature and humidity are in all flats uniform.

Real building annual consumption of energy, gained as a result of heat consumption monitoring is e_a = 39,9 kWh / m^{2}a.

Fig. 3 Apartment house in Železný Brod – main facade

4 Conclusions

The results of experimental examinations of two low-energy buildings are:

- both buildings meet energy requirement for low-energy houses,
- experimental value of annual energy consumption of buildings is approximately 10 % less than calculated value,
- when heating system with thermostatic valves and individually controlled ventilation system with heat recovery is properly used, the temperature and humidity of internal air in winter period is on the expecting level,
- improper use of heating and/or ventilation systems leads to expansion of heat consumption.

References

[1] KULHÁNEK F. *Low-energy and low-cost building for Czech Republic*, Housing of the third millenary, pp.38-43, Building Information Publishing, Prague 2004.

[2] KULHÁNEK F. *Low-energy and low-cost building – implementation of project*, Proc. of International Conference „Thermal protection of buildings“, High Tatras, Slovakia, 2005.

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