LIGHT EXTERNAL WALLS AND THERMAL STABILITY OF ROOM

  

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Summary

The thermal stability of room is influenced by the size of windows and their orientation towards different points of the compass. Undesirable summer overheating can be prevented by reducing the window size, suitable insulation, or a better choice of glazing. The article deals with the results of the surveying and simulation of a room with large glassed areas and light external walls in summer.

Keywords: Summer overheating, thermal stability of room, light external wall, window, indoor microclimate, indoor temperature

1 Introduction

Adequate microclimate conditions have to be guaranteed in living rooms and in rooms that are used frequently and for longer periods. These conditions have to be guaranteed in winter and also in summer. The structure and materials from which it is constructed play a big part in creating an ideal living environment. The thermal comfort is often broken if we use light external walls together with large glassed areas. One of the most important claims ensuring thermal comfort is the thermal stability of the room and also the maximum internal temperature in summer. The temperature of a room should be stable; if it is indoor temperature in point of time is in permitted limits. Building materials used mainly for boundary constructions such as external walls, roofs and windows, significantly influence the thermal stability of room.

2 Characteristics of classified room environment

For the examination of indoor microclimate heat stability purpose we chose a room in a building, which serves as a school and also for research purposes. The room is used as a staff workroom for 3 people without air conditioning. The facade with large glassed area is facing west. The measuring was carried out at the period from 30. 6. 2006 to 10. 7. 2006. During the measuring the room was used ordinarily.

The external wall of the investigated room is light, aluminium, prefabricated and with large glassed areas. The floor is made from steel bearing members on which there is placed trapezoidal metal and reinforced concrete. In all the rooms there are demountable acoustic ceilings made of mineral boards. The floor finish is made of linoleum. Internal partition walls are constructed from plasterboard filled with mineral insulation.

Fig. 1 Assessed building and detail of shielding element

3 Legislative requirements

Convenient microclimate conditions have to be guaranteed in living rooms and in rooms that are determined for a permanent use. These conditions have to be guaranteed in winter and also in summer. The conditions are expressed by parameters of indoor microclimate.

These parameters are:

- Operative temperature or internal dry resultant temperature (globe temperature)
- Speed of airflow in a room
- Relative internal air humidity

Thermal comfort impacts subjective well-being, relaxation factor and real labour productivity more than unfavourable emissions and noise. According to foreign studies one-hundred-percent perform of doing light work is at the temperature of 22 °C. At the temperature of 27 °C the ability to produce full output is about 25 % lower, at the temperature of 30 °C it is only 50 % of the optimum. The thermal comfort is also influenced by surface temperature of constructions that create the space.

To ensure favourable rate of thermal losses caused by flowing and radiation there is a so-called maximum allowed difference of internal temperature and surface temperature of the room construction element. For residential buildings and office buildings there is an acceptable value of the so-called summary temperature. This is the temperature that is a summary of internal temperature and surface temperature of the room elements. This temperature cannot be over the required limit:

$$\theta_i + \theta_{si,m} \leq 51°C \,,\ \theta_{i,\max} \leq 27°C \text{ and } \theta_{si,\max} \leq 27°C$$

The acceptable values of microclimate conditions depending on heat production of the human body are determined in the law 523/2002 Sb. The types of work are divided into groups according to the total average energy expenditure M ($W.m^{-2}$) of the effective labour time. The room environment of the aforementioned building can be classified according to demands of labour class I or class IIa. The labour with the minimum of moving and total average energy expenditure less than 80 $W.m^{-2}$ is included in labour class I. This is generally deskwork with light manual labour. Standing work and flat floor walking with the total average energy expenditure ranging from 81 $W.m^{-2}$ to 105 $W.m^{-2}$ is included in labour class IIa.

Tab. 1 Acceptable values of microclimate conditions

Labour Class	Average energy expenditure M ($W.m^{-2}$)	Operative Temperature (°C)			Air Flow Speed ($m.s^{-1}$)	Relative Internal Air Humidity (%)
		minimum	optimum	maximum		
I	≤ 80	20	22 ± 2	28	0,1-0,2	30-70
IIa	81-105	18	20 ± 2	27	0,1-0,2	

Microclimate conditions of permanently used rooms are also determined by edict 6/2003 Sb.

Tab. 2 Microclimate conditions according to edict 6/2003 Sb.

Kind of Room	Internal Dry Resultant Temperature	
	Summer	Winter
Boardroom, classroom	24,5 ± 1,5	22 ± 2,0

ČSN 73 0540 – 2 Thermal protection of buildings – Requirements determines thermal requirements of design and verification of buildings with requirement room environment during use. According to building law these requirements ensure economic meet of basic requirement of energy saving and thermal protection.

The functional requirement of thermal stability of a room meets with the conditions of interior thermal comfort. Thermal stability describes thermal properties of a space in the term of external conditions. A room has to ensure the maximum rise of the interior temperature in summer $\Delta\theta_{i,max} \leq \Delta\theta_{i,max,N}$. Also the maximum interior temperature $\theta_{ai,max} \leq \theta_{ai,max,N}$ has to be ensured . Fulfilment of these requirements in the term of energy savings should be secured by the structural design without use of air conditioning.

Tab. 3 Summer period requirements according to the standard ČSN 730540-2

Kind of Building	Maximum Rise of Interior Temperature in Summer $\Delta\theta_{ai,max,N}$ [°C]	Maximum Interior Temperature in Summer $\theta_{ai,max,N}$ [°C]
Nonproductive	5,0	27,0

4 Simulation and experimental measuring

Software B-Sim 2002 was used for calculating a simulation of thermal property of an internal environment. As input data for simulation we used external temperatures and values of sun radiation that were measured in the weather station located in the Faculty of civil engineering in Brno. The condition of a room was simulated according to the data taken, in order to compare results with values from experimental measurement.

For the entire measuring the following equipment was used – universal measuring stations ALMEMO 3290-8 and ALMEMO 2290-8 which were connected to thermocouples T 683-2 NiCr-Ni, capacitance detectors FH A 646-1 (temperature and air moisture), anemometer MT A450 20MA and dry resultant temperature thermometer.

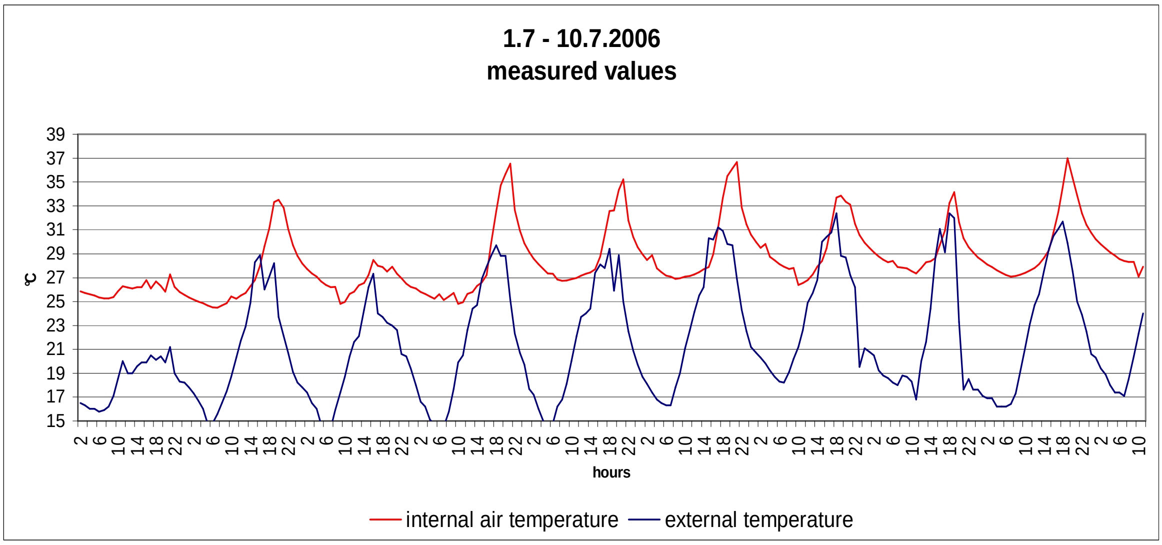

Fig. 2 History of internal and external temperatures gained by measuring

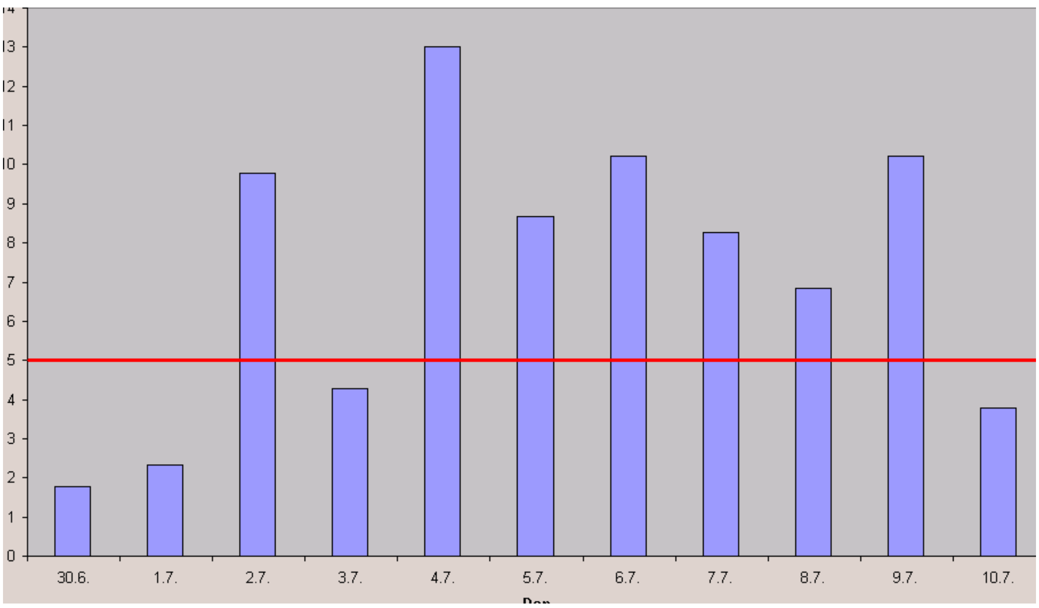

Fig. 3 The maximum rise of the interior temperature

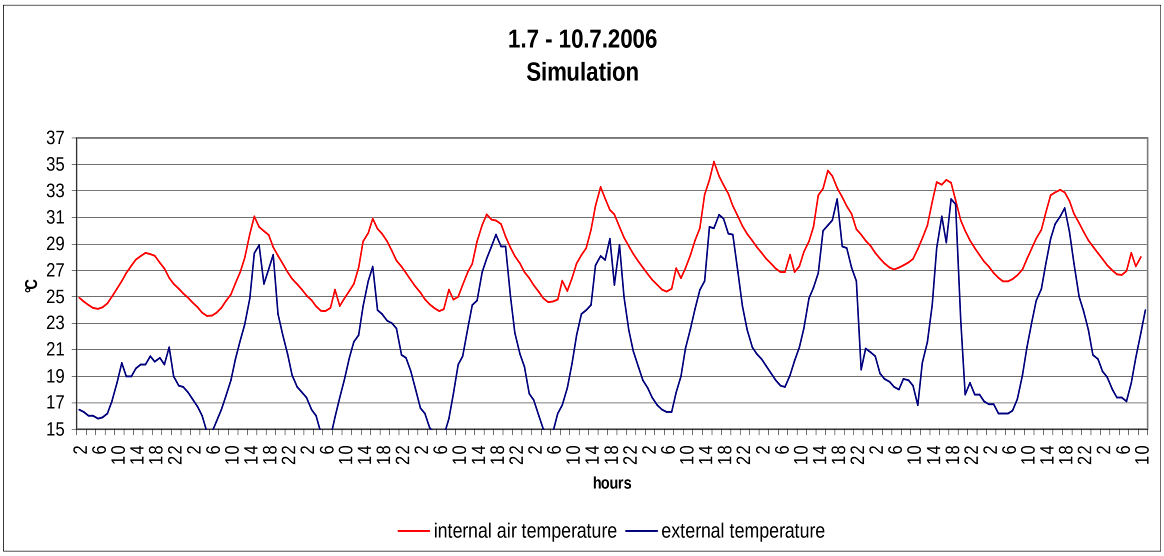

Fig. 4 History of internal and external temperatures gained by simulation

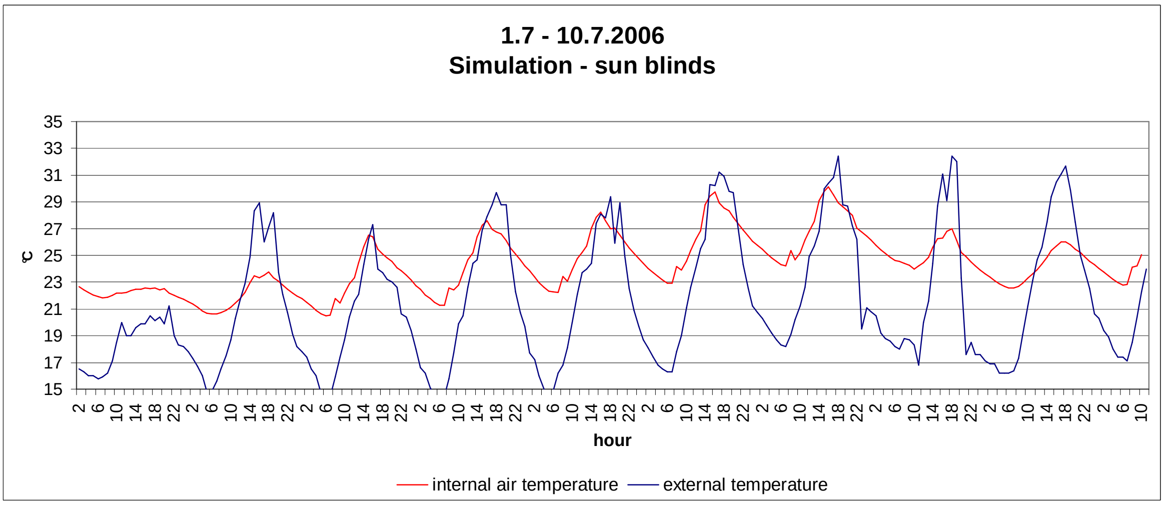

Fig. 5 History of internal and external temperatures gained by simulation. Sun blinds are used all time

5 Conclusions

Simulation results by software B-Sim 2002 correspond to the measured values. Slight differences are the cause of room use schedule – natural ventilation and manual positioning of external sunblinds that cannot be unambiguously taken in account by simulation process. If there is force ventilation in the room and sensor controlled positioning of sunblinds, it is possible to simulate internal microclimate by B-Sim and to design the building in a better way. All rooms in this building should fulfil the conditions of thermal comfort all year round. It is necessary to design a so-called intelligent building and to operate its systems by integrated operation systems.

It is important to provide the possibility of operating heating, ventilation and shading systems on the basis of heat insulating and storage properties of the building, changing operating conditions and climatic effect and replace static operation of energy demanding systems by controlled systems. These systems are able to optimise energy use depending on properties and use of the building. The control highly affects internal comfort and energy savings, even if it is an indispensable sum of capital expenditure.

References

[1] ČSN 73 0540, parts 1 – 4. Český normalizační institut. Praha
[2] Regulation 6/2003 Sb.
[3] Regulation 523/2002 Sb
[4] Software B-Sim 2002

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