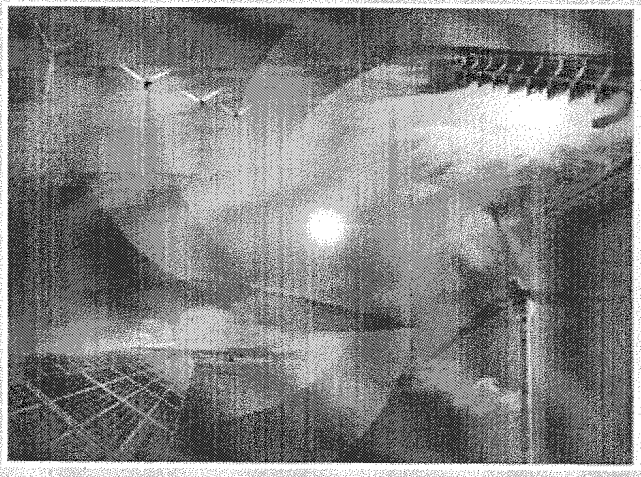

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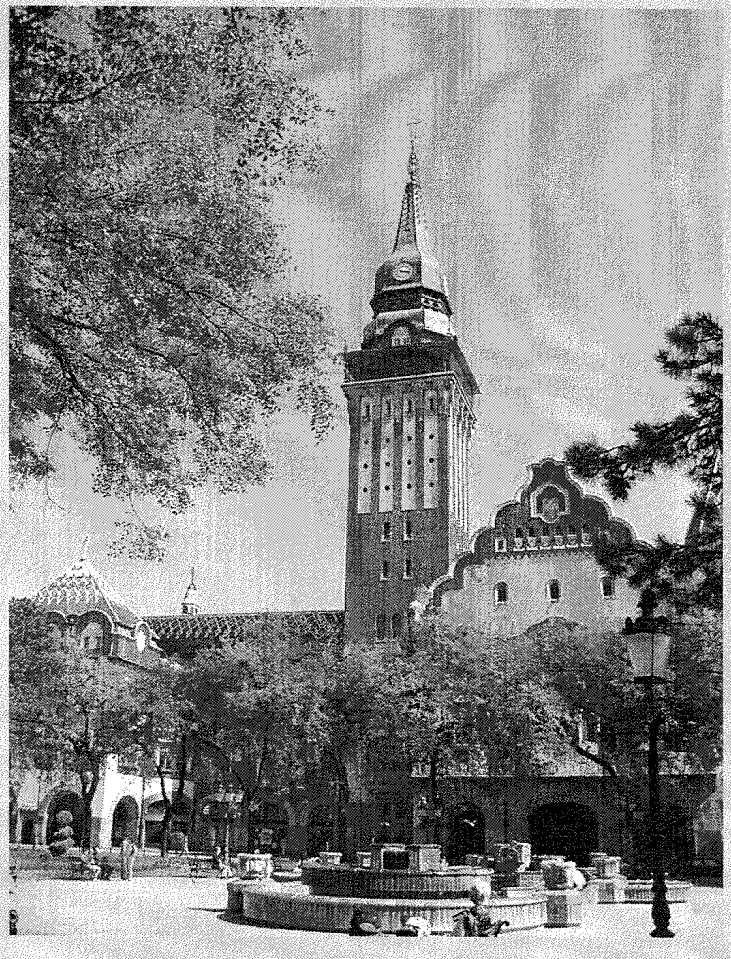

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SIMULATION AND MEASUREMENT OF THE INTERNAL AIR TEMPERATURE IN PRIVATE OFFICES

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Nowadays the facades of newly built buildings have significant glazed surfaces. This paper presents the results of a simulation and measurement of internal air temperature in summer period in private offices.For internal air temperature simulation CASAnova software was used, in order to compare light, medium building structures and air change rate in private offices.

Keywords: *simulation, measurement, indoor temperature*

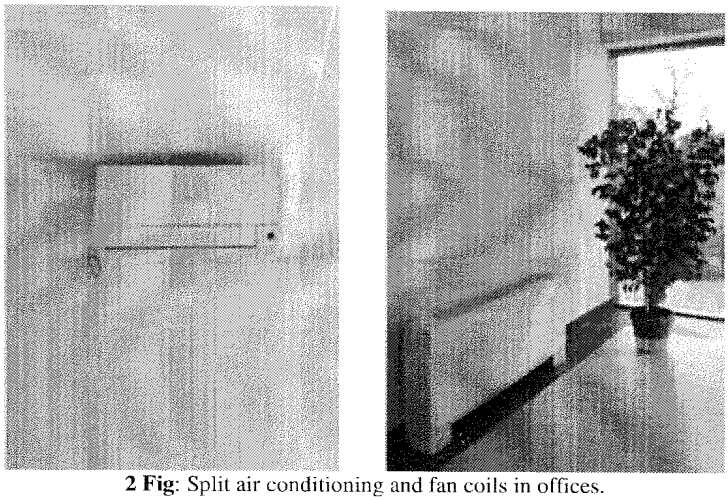
Introduction

In present days the architectural trend is to provide buildings with large glazed surfaces.

1 Fig: Forest Offices Building in Debrecen [1]

In these type of buildings in summer period the huge heat load causes discomfort feeling in those who uses the offices.
The variation of the indoor air temperature it has a high importance to assure the optimal comfort necessary for intellectual or physical work.
At the same time the indoor air temperature can be kept between the comfort limits if the occupants use the

building and its service systems in a proper way. [2,3,4,5,6,7,8]

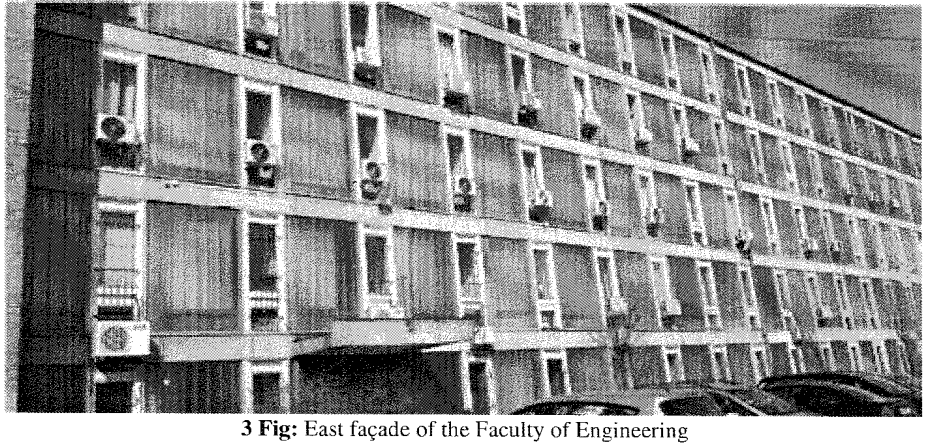


2 Fig: Split air conditioning and fan coils in offices.
Usually in office's the cooling is assured using split air conditioning systems or fan coils.

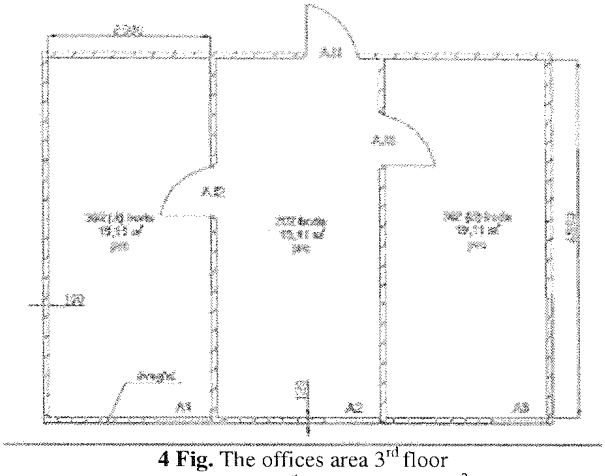
Offices presentation

The University of Debrecen, Faculty of Engineering's building can be found in Ótemető street, 2-4. The educational building has five floors (Ground floor + 4 floors). The Faculty has significant glazed surfaces in the facade. East façade and the external split units are shown in the following figures.

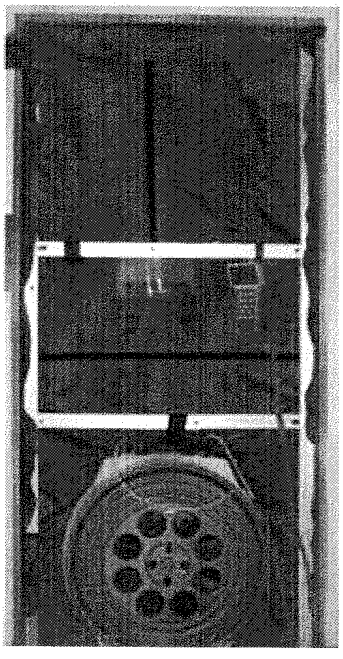
Private office: An enclosed work space for one person, suitable for activities which are confidential, demand a lot of concentration or include many small meetings. [9] The office's area of the east orientation is shown in the following figures.



3 Fig: East façade of the Faculty of Engineering



4 Fig. The offices area 3rd floor
The area of the 1st office is 19.11 m^2.



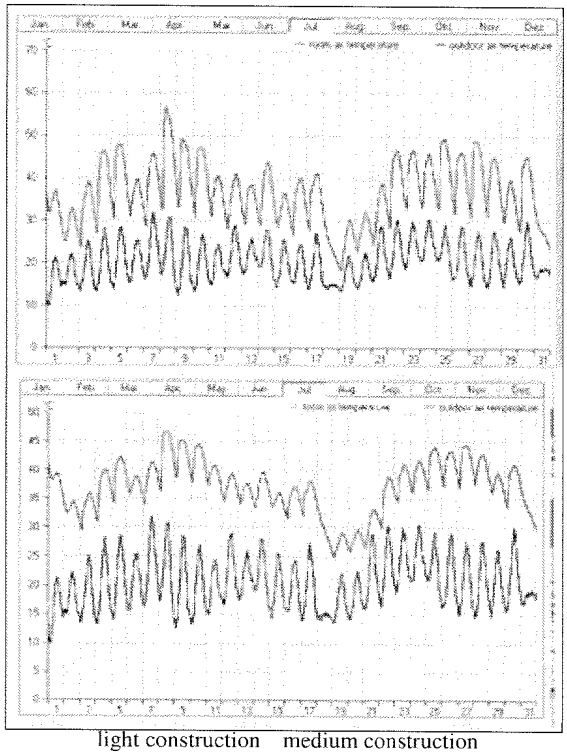
5 Fig. Blower Door during measurement

With a Retrotec 3300 Blower Door measuring equipment the air tightness of the offices was measured:
Method of the measurement: the measuring equipment which consist pressure sensor, fan, and cloth door panel were built in the offices exterior door (fig.5). Doors and windows must be closed.
The operating principle of the "Blower-door" is that; in the inside of the office we made an 50 Pa pressure and we examined the flow rate. Similarly we can make the depressurization measurement too, but inversely. [10,11]
The air flow, air change rate and effective leakage area (eqla) is shown in the following table.

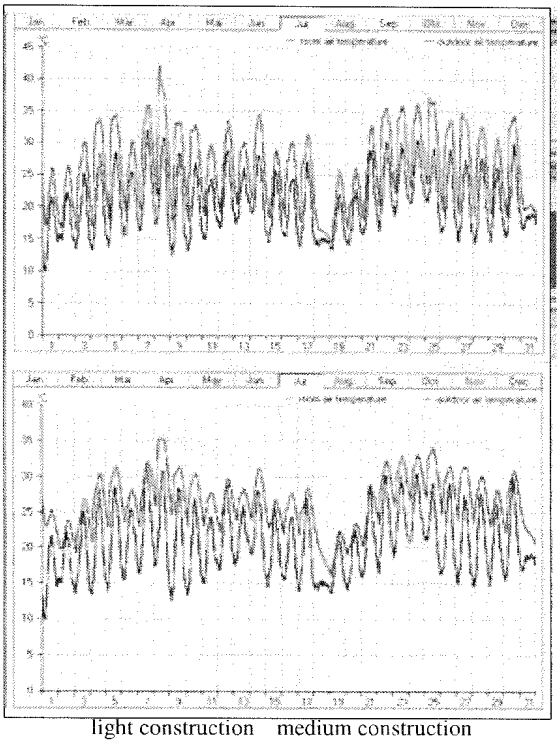
1 Table: The value of measurement with Blower Door

	Office's Pressure:	+/- Pressure:	Air flow: [m^3/h]	Eqla: [cm^2]	Air Change rate: [h^{-1}]
302A	10 Pa	Pressurize	195	218	3
		Depressurization	128	134	2
	30 Pa	Pressurize	443	285	7,5
		Depressurization	406	261	6,5
	50 Pa	Pressurize	592	295	10
		Depressurization	605,5	302	10
302	10 Pa	Pressurize	206	231	3,5
		Depressurization	394	249	7
	30 Pa	Pressurize	262	263	4,5
		Depressurization	534	312	9
	50 Pa	Pressurize	432	269	7
		Depressurization	660	321	11
302B	10 Pa	Pressurize	132,5	144,5	2
		Depressurization	287	323	5
	30 Pa	Pressurize	250	161	4
		Depressurization	553	356	9
	50 Pa	Pressurize	345	172	6
		Depressurization	767	382	13

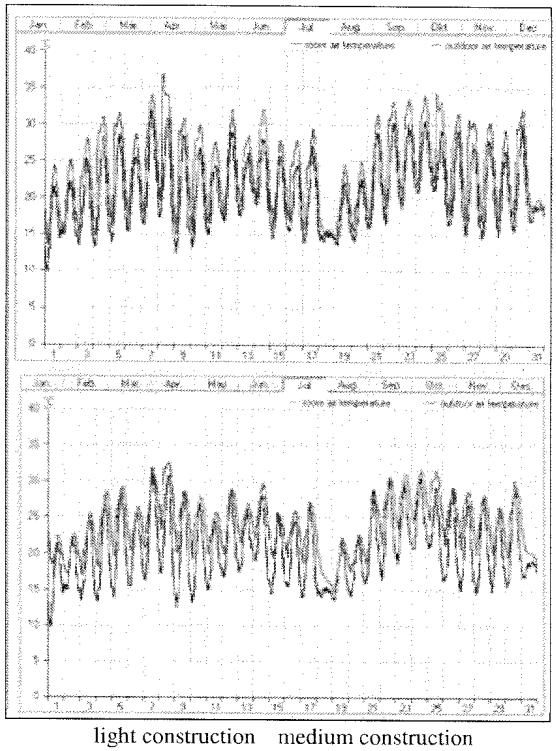
Air temperature simulation in one private office
The software's possible settings in working planes are: geometry, windows, insulation, building, climate zone. In Building menu is possible to set the natural or mechanical ventilation and heat recovery efficiency.
The above diagram shows the indoor and external air temperature with different months



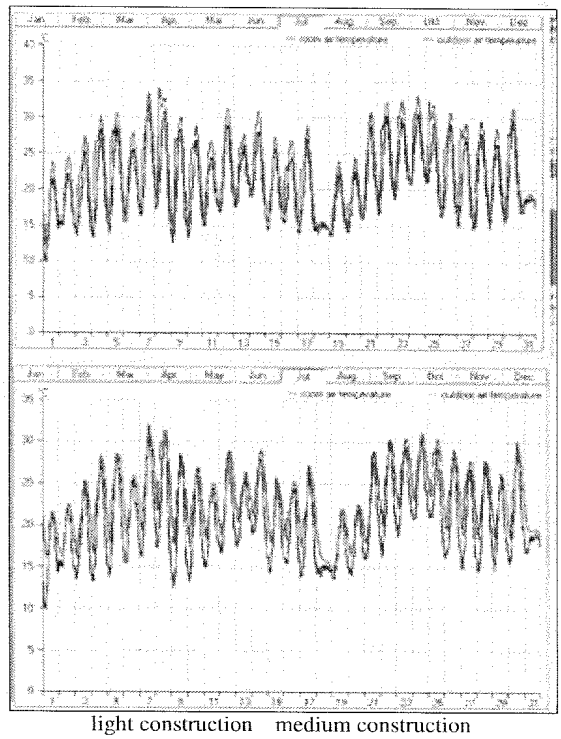
light construction medium construction
6 Fig. indoor and outdoor air temperature 0h-1 natural ventilation in July



light construction medium construction
7 Fig: indoor and outdoor air temperature 3h-1 natural ventilation in July



light construction medium construction
8 Fig. indoor and outdoor air temperature 6h-1 natural ventilation in July

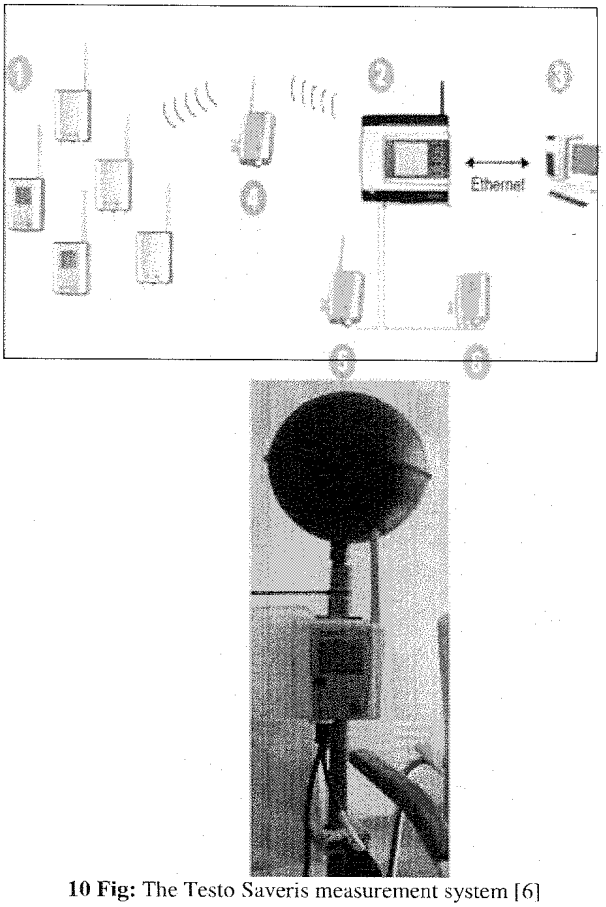


light construction medium construction
9 Fig. indoor and outdoor air temperature 9h-1 natural ventilation in July

Generally in figures 6;7;8;9 the amplitude of the internal air temperature variation change compared with heat storage mass and the air change rate.
Generally, we can conclude that for light structure the amplitude of the internal air temperature variation is higher compared with the medium structure.

The Testo Saveris measurement system

This measurement system can also be used for monitoring building air conditioning.



10 Fig: The Testo Saveris measurement system [6]

With the measurement system, ambient or process data for temperature and humidity in sealed rooms and/or during transportation is measured and recorded using probes (1). These measured values are transmitted by radio to the Saveris base (2) and saved. A router (4) can be used to optimize the radio signal in the event of difficult structural conditions. The data is then called up from a computer (3) by the Saveris base and saved to a database.

Very long distances can be bridged using a converter (5), which converts the radio signals of the probe or router and then transmits this measurement data to the base via an Ethernet cable. The so-called Ethernet probes (6) can also be connected to the base using an Ethernet cable.

NTC sensor measuring range of the Saveris T2/T2D is from -35 to +50 °C and the accuracy is ± 0.2. °C (-25 to +70 °C). [12]

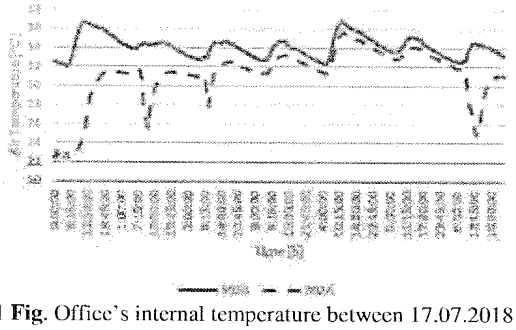
Measured air temperature in the private office

The building of the Faculty of Engineering is medium and heavy weight structured and some of the offices has the following heat storage mass:

East Office III floor 10744,57 kg (562,24 kg/m^2)

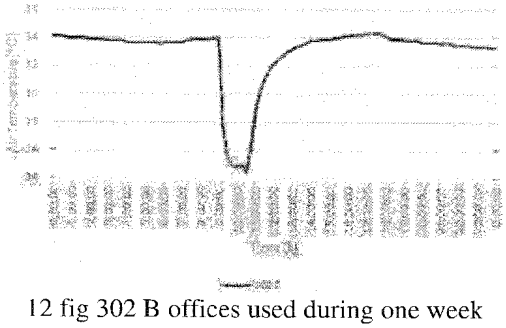
In measurement period the maximum external air temperature in summer days was: 29.8 °C, 25.2 °C, 29.6 °C, 29.3 °C, 31.3°C, 28.9 °C and 29.7°C.

Temperatures measured in 7-day period in offices are shown in the following figures.



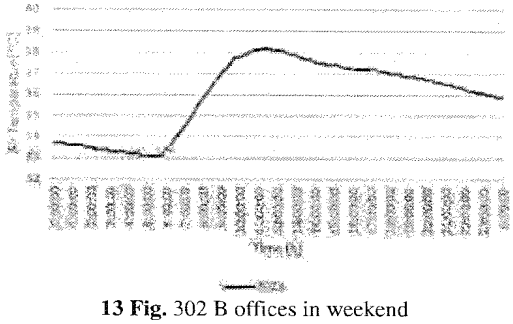
11 Fig. Office's internal temperature between 17.07.2018 – 23.07.2018

Figure 11 shows the internal temperatures in eastern offices in week days and weekend, 302 B not used, 302 A used.



12 fig 302 B offices used during one week

The above diagram, shows that in summer period offices are not used. During summer holiday, the Faculty's staff uses less the offices that in any other period of the year, therefore the indoor air temperature is high, because split air conditioning systems are not in use in this period.



13 Fig. 302 B offices in weekend

In the above figures the daily minimum and maximum hourly internal air temperatures are shown.

In study period's weekends private or double offices are rare used and because of the huge glazed surfaces the overheating is guaranteed.

Conclusion

In present paper the internal air temperature variation is presented in a critical private office of a building. The maximal accepted value of the internal air temperature in summer period is 26 °C.
In certain rooms in certain period of time the indoor temperature considerably (12 °C) passes the acceptable 26 °C- during summer period.
It is also presented as a result of the simulation, that the natural ventilation helps to temper the building structure and in finally reduce to internal air temperature.
The external surface of the analysed building is surrounded with asphalt and concrete. The asphalt's and concrete's thermal properties are not the same as for natural surface.
In urban areas the heat source is responsible for the external air temperature. Because in city's the natural surface were changed to asphalt and concrete.

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