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CHILLED BEAMS AS A SOLUTION TO ACHIVE INTERIOR MICROCLIMATE FOR AN OFFICE BUILDING

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Abstract

Bucharest is Romania's capital,and in the north of this town from Romania it is a place located in Baneasa and on this surface it is intended to be built a construction having offices and administrative offices destination. Ensable wich make the object of study consists of two buildings and I decide that the cooling beams are a very good solution for air conditioning because they perform two functions : heating and cooling. These cooling beams are two types : active beam and passive beam.Both of them are very useful,but the difference between them is this one : For passive chilled beams, the heat transfer is done by radiation and convection, while in case of active chilled beams, heat transfer is enhanced because of recirculated air that is driven within the phenomenon of induction by introducing fresh air via a heat exchanger.

Key words*: cooling beams,heat transfer ,radiation, convection ,recirculated air, heat exchanger, active beams, passive beams.*

INTRODUCTION

Bucharest is Romania's capital, a city with a population of 2,106,144 residents in 2016 according to the National Statistics Institute. (INS, 2016)
It is intended that on a surface located in Baneasa area to be built a construction having offices and administrative offices destination, and it heating-cooling system to be adopted in a version that fully use the existing potential in the site.
Starting from the geological and hydrogeological context of north Bucharest area, where lithology and aquifer layering are favourable, it was analyseda solution for using of geothermal well to support the needs of the heating-cooling system for office building to be designed, I proposed the constructive solution based on cooling beams.

MATERIALS AND METHODS

Ensemble which make the object of study consists of two buildings:first of them has a height B + GF + 6F + Ftehand it is a building with mixed functions (offices, halls for meetings, etc.), and the second building has regime of height GF + 4F and has the function of shopping complex at the ground floor and office space eventually used in operating leasing regime to a third party (BAU, 2014).
General heating-cooling system will consist of 78 geothermal wells, 98.25 m depth each, connected to a heat pump, ground has an output of 240 kW and will produce heat temperature to 450C for tour circuit (Tt) and for return circuit the temperature will be of 350C.
The heating source that will be designed, will consist of three wallboilers, one ground-water heating pump and a chiller that works only for water coolers.
Nominal thermal power of each boiler will be 150 kW and produces a heat value of 550C to 350C for tour circuit and return circuit. The boilers are equipped with modulating burners (burners where the flame is constantly changing his geometry, making it possible to maintain the temperature or pressure parameter with a certain precision, adjustable around a preset value).
For water-cooled air conditioning system it will be provided the following: an aggregate of air cooled condenser which produces chilled water

and a ground-water heatingpump (located in theadministrative space in the basement) equipped with vertical wells.
Ground-water heating pump is equipped with vertical geothermal wells and has a capacity of358 kW heating and cooling capacity is 418 kW. For the same purpose, it will be used a chiller equipped with a cooling water condenser. This chiller has a cooling capacity of 600 kW.
To obtain thermal comfort conditions, it was designed a heating system based on beam cooling; the facility is made up of four main pipes.
The operating principle of cooling beams is as follows (Figure 1):
1.Primary air (outdoor air dehumidificated) into supply air supply chamber
2.Primary air is supplied through small nozzles.
3.Primary induces room air supply air to be re-circulated through the heat exchanger of the chilled beam.
4.Re room-circulated air and the primary air is mixed prior to diffusion in the space
5.Cold water connection.
6.Warm water connection.

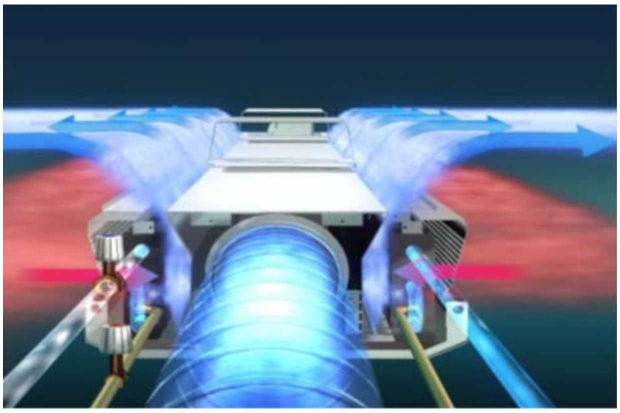

Figure. 1 Operation principle of cooling beams (Virta et al, 2006)

For passive chilled beams, the heat transfer is done by radiation and convection, while in case of active chilled beams; heat transfer is enhanced because of recirculated air that is driven within the phenomenon of induction by introducing fresh air via a heat exchanger. The difference between active and passive beams is evidenced in Figures 2 and 3.

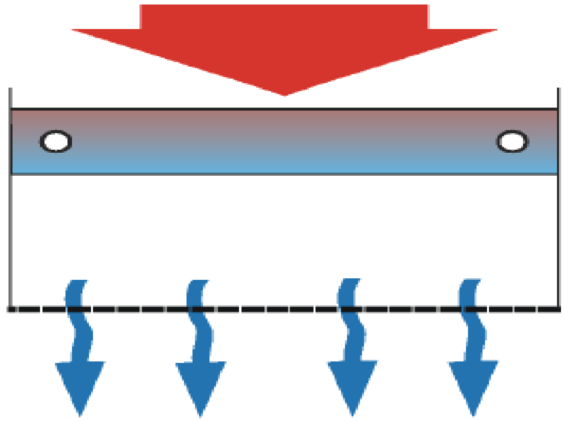

Figure 2. Passive beam (Virta et al., 2006)

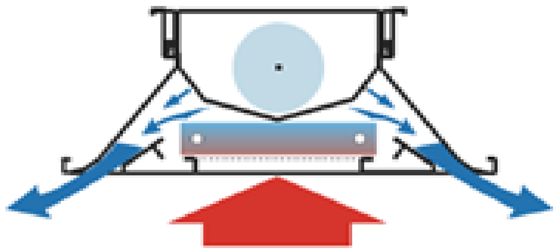

Figure 3. Active beam (Virta et al. 2006)

RESULTS AND DISCUSSIONS

For system sizing, it is required the calculation of heat loss calculation based on which it will be establishes the heating-cooling system configuration.
Heat loss calculation was done according to STAS 1907/1-2014 (ASRO, 2014), based on the following assumptions: the internal temperature for offices is of 150C, for meeting rooms, toilets are of 220C, for kitchen is of 180C, for technical areas is of 150C, and relative humidity is uncontrolled.
The relationship calculation is applied for each floor:

$Q = QT + 1(\frac{\sum A}{100} + Q) + Qi$, where:

QT– the low of heat lost through the construction elements
Qi– the flow of heat needed for heating the incoming cold air in the room
A – additions to heat loss through transmission.

QT = Qe+ Qp,where:

Qe– heat losst hrough building elements that separate two identical environments but with different thermal potential.
Qp– heat loss through building elements in direct contact with the ground.

Qi= max (Qinfiltration, Qventilation) + Qdoor ,where:

Qi – needed heat to heating coming cold air into the room
Qinfiltrations,ventilation– heat flow for heating cold air entered the room through infiltration / ventilation
Qdoor– the flow of heat to cold air warming entered the buildings through open doors.
For example, for the 1st floor of the building it results:

Table 1. Calculation of heatloss for determination of heatingneed for the 1 st floor

Name of room	Ti [°C]	QR [W]	Qp [W/mp]
E1.01- Hall	24	4.726	71
E1.02-Open space	24	12.013	60
E1.05-Server	20	1.636	334
E1.06- Kitchenette	24	3.503	141
E1.07-Open space	24	20.893	68
E1.19-Extention	24	12.013	60
E1.20- Kitchenette	24	2,762	173
E1.09- Hall	24	4.670	35
E1.12- Meetings room	24	2.082	74
E1.13-Oficiu	24	1.220	165
E1.14- Meetings room	24	3.468	136
E1.15- Meetings room	24	2.704	90
E1.16- Meetings room	24	3.264	104
E1.17- Meetings room	24	4.764	119
E1.18- Meetings room	24	3.783	126
E1.19- Meetings room	24	2.777	161
Σ S + P +6		57547	
Σ P+4		28.732	
ΣTOTAL		86.278	

Heat dissipation and contributions were calculated in accordance with STAS 6648/1 (ASRO 2014) based on the following assumptions: outside temperature of about 36^0C, inside temperature for offices and meeting rooms of about 24^0C, relative humidity is uncontrolled.
Heat dissipation and contributions were calculated in accordance with STAS 6648/1 (ASRO, 2014) and include: consideration of heat throught the window type inertial elements, input elements of heat through walls inertial type, terrace, input heat from neighboring rooms unconditioned, releases heat from electrical lamps and releases heat from occupants.
For example, for the 1st floor of the building it will result:

Table 2. Calculation of releases and incoming heat for determination of heating need for the 1st floor

Denumireincapere	Ti [°C]	QR [W]	qR [W/mp]
E1.01- Hall	24	4.726	71
E1.02-Open space	24	12.013	60
E1.05-Server	20	1.636	334
E1.06-Kitchenette	24	3.503	141
E1.07-Open space	24	20.893	68
E1.19-Extention	24	12.013	60
E1.20-Kitchenette	24	2,762	173
E1.09- Hall	24	4.670	35
E1.12- Meetings room	24	2.082	74
E1.13- Office	24	1.220	165
E1.14-Meetings room	24	3.468	136
E1.15-Meetings room	24	2.704	90
E1.16-Meetings room	24	3.264	104
E1.17-Meetings room	24	4.764	119
E1.18-Meetings room	24	3.783	126
E1.19-Meetings room	24	2.777	161
Σ S+P+6		57547	
Σ P+4		28.732	
ΣTOTAL		86.278	

Based on these analytical determinations for the 1st floor, which was taken as an example calculation, I chose to use six variants beams induction type DISA cooling, 4 pipes each, as follows:

Table 3. Summarizing table of heating-cooling beam bodies used

No	Cooling beam	No	Oi	OR
	[mm]	-	[W]	[W]
1	1800x300	6	1049	467
2	1800x600	14	1977	1018
3	2100x600	4	2440	1189
4	2400x600	3	3009	1407
5	3000x300	16	1270	527
6	3000x600	36	3139	1439
ΣTOTAL		79	186.083	86.287

Basically, choosing the total number of bodies and their power is imposed by the cooling function, the heating function becoming more oversized. But there is the possibility of using graded to this option, in accordance with the comfort desired.

All these beams are equipped with condensation sensors and are ceiling mounted.

CONCLUSIONS

The buildings require an interior microclimate, according to the main destination. It includes heating, cooling interiors spaces for each season separately.

Solving solutions are multiple, the consumption varying accordingly.

One of the most modern solutions is the use of so-called cooling beams which have a double function (heating-cooling), which is accompanied by benefits related to:

-comfortable indoor climate conditions (desired air temperature, low room air velocity, low noise in operation)

-economical life cycle (competitive investment cost savings in running cost, limited maintenance requirement, easy to use with free / low energy systems)

-hygienic solution (dry coil operation, no drains or filters, openable construction for easy serviceability and cleaning).

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