NEW SISTEMS FOR BUILDINGS CONFORT

NOI SISTEME PENTRU ASIGURAREA CONFORTULUI ÎN CLĂDIRI

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Abstract. *Comfort in buildings is determined by several factors among which we mention the state of thermal comfort, sound, smell, sight and touch, not to mention the psychological or environmental factors. In the beginning of the millennium the world is facing many challenges more or less serious. One of the challenges in buildings domain is just finding the perfect balance between achieving the safety, health and comfort and of course ensuring energy efficiency according to the driving sustainable development. This paper examines some constructive systems that can meet the conditions of hygiene, comfort and efficient energy, and underline the solution of combining two already known and widely used systems: the ventilated facades and Canadian or Provençal well. The vegetation enhace the ambiental effect of this sistem and it may be located within interior ventilated facades or to outdoor of buildings envelope.*
Key words: thermal comfort, natural ventilation, Canadian well, vertical gardens

Rezumat. *Confortul în clădiri este determinat de o serie de factori între care enumerăm starea de confort termic, acustic, olfactiv, vizual şi tactil, ca să nu mai amintim de factorii psihologici sau ambientali. În acest început de mileniu lumea se confruntă cu o multitudine de provocări mai mult sau mai puţin grave. Una dintre provocările domeniului construcţiilor este însăşi găsirea echilibrului perfect între realizarea condiţiilor de siguranţă, igienă şi confort concomitent cu asigurarea unei eficienţe energetice în acord cu pricipiile Dezvoltării Durabile. Lucrarea de faţă analizează câteva sisteme constructive care pot satisface condiţiile de igienă, confort şi eficienţă energetică şi indică o soluţie în combinarea a două sisteme deja cunoscute şi larg utilizate: faţada ventilată şi puţul canadian sau provensal. La potenţarea efectelor de ambientare, va contribui şi vegetaţia, care poate fi amplasată spaţial în cadrul sistemului nou creat, in interior sau in exterior.*
Cuvinte cheie: confort termic, ventilare naturală, puţ canadian, grădini verticale

INTRODUCTION

This paper will highlight aspects of comfort parameters in buildings and natural ventilation of buildings, also new methods and technologies applied to meet sustainable development in construction: safety, durability, hygiene, and comfort and energy effieciency.

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MATERIAL AND METHODS

Humans can get feeling of comfort depending on several factors and a rather limited range of values of temperature and humidity. Natural ventilation of buildings, indispensable for indoor air quality and comfort, requires some energy for heating /cooling of fresh air. Natural ventilation of buildings can be achieved either by opening windows or channels or special towers for ventilation, where air is circulated through the temperature and pressure differences between inside and outside the building and the air's natural tendency to climb, leaving cooler air to enter the building on the lower level. One of the applications of natural ventilation, efficient in saving energy for preheating / precooling air ventilation, it is the Canadian (Provençal) well. In principle, this system requires the introduction of air into the building through a channel placed at a certain depth in the soil, to raise the temperature in cold season, and for cooling during the warm season.

RESULTS AND DISCUSSIONS

Below, we illustrate, according to the author's previous work (Purcaru, 2011, a), several examples of energy efficient buildings that use multiple methods and technologies for conservation and green energy production, meeting all conditions hygiene and comfort of international public buildings. It also presents the results of an experiment on natural ventilation in buildings and construction elements, made in the Technical University “Gheorghe Asachi” of Iasi, Faculty of Civil Engineering and Services.

Building for offices and training facilities to tax consulting in Stuttgart, Germany (Hindrichs and Klaus, 2007) is near the city center and business centers zone, at the intersection of two major traffic arteries, being visible from all directions.

Building envelope was designed to meet all customer requirements and location: the office is very well lit and naturally ventilated, but still not exposed to noise and pollution inherent to a dense traffic area. So we opted for a double glass façade, naturally ventilated through a heat tunnel, located in the basement, with the sectional area of 1 m^2, the length of 500 m, and the walls 20 cm thick concrete to store the heat of air in summer, and then releasing it in winter (fig. 1). Outside air is introduced into the building pre-cooled or pre-heated according to season, during its passage through that tunnel and then entered in the ventilated façade through vertical pipes. Stack effect of air promotes its distribution at each level of the building.

Fig. 1- Thermal labyrinth in horizontal section (left) and ventilated façade section (right), (Hindrichs and Klaus, 2007).

"Solar XXI" is one of high energy efficiency buildings, built in Lisbon, Portugal and operational in 2006. According to this building project is based on several concepts that promote energy efficiency in buildings, such as good insulation outside the building, the orientation most commonly occupied areas to the south, proper shading of the windows of these spaces, photovoltaic panels, underground piping system for precooling / preheating air needed in building ventilation (fig. 2), lighting and natural ventilation of the building.

Fig. 2 – Detail in the plan (left) and section (drapta) of underground piping system for building ventilation and air conditioning, (Oliveira Pano and Gonsalves, 2011)

"Energon" is the largest building in Europe constructed acording to passive house standards whose project started in a competition held in 2000 (Faigle, 2005). In the next year, they began the construction of the building, and finalized after a year. This building has five levels distributed around an atrium of the same height (fig. 3, left), covered with glass panels and integrate in its structure all the techniques and most efficient solutions to save and recover heat and power and also the green energy production tecniques (photovoltaic panels integrated into roof).

Fig. 3 – Overview of the EnerGon building exterior (left), natural ventilation circuit diagram of the last level (middle), air vents absorption system for underground wells (right), (Faingle B.,2005), (Lindemann, 2007)

Among these techniques show the following (Faingle, 2005; Lindemann, 2007): special prefabricated curtain walling façades curve shape, having a high thermal insulation, both in the opaque and glazed area; glass-covered central atrium acts as a distributor of fresh air in offices, air conditioning with an active thermal concrete core (fig. 3, middle); heating is done by a biomass boiler in proportion of 80%, but also by heat recovery devices for cooled IT area and kitchen area; cooling due to 40 geothermal wells, each one with 100m depth (fig. 3, right).

During the first year of operation they have done researchs to evaluate energy efficiency and building costs, technical equipment, but also comfort, highlighting the efficiency and performance of the building, compared with other buildings in the same category, but not use technologies mentioned above.

In our country has made a first step in developing research programs in passive building technologies, currently being built by the Polytechnic University of Bucharest, an passive house experimental building equipped with Canadian well. Monitoring behavior of this building after its using, it will provide a very useful material for the improvement and generalization of the system.

On Technical University of Iaşi, in the author's doctoral research is done an experiment that simulated a small-scale natural ventilation of a ventilated façade channel coupled to a Canadian well. This experiment followed the potential energy of the ground, but at the same time avoiding adverse aspects of this system. Typically, Canadian shaft introduced the pre-cooled or pre-heated air directly into the room, including the possible infiltration of radon, odors, fungus, spores that grow in underground pipes system.

Fig. 4 - Overview of experimental model of a Canadian well pipe coupled to ventilated facade channel (right) detail of Canadian well model immersed in water (left)

The operating principle of the model (fig. 4) is based on the criterion of similarity Grashof, which says that the report between buoyancy force and friction force is constant. Thus, compliance the conditions of equation (1)

$$(\Delta T L^3)_{\text{prototype}} = (\Delta T L^3)_{\text{model}}, \quad (1)$$

where ΔT is temperature difference and L is the length, which provides to the model conditions similar to reality, would require, in addition to geometric similarity (the model is 1:5 scale) to work with much larger temperature differences than those from nature and would not be acceptable in the laboratory (1000°C). According to the previous proposal in Department of Civil Engineering, (Radu et al., 2008) it may proceed backwards, applying small temperature differences to model-scale and inferring temperature differences much lower to natural scale.

Following measurements (temperature and air velocity in ventilated channel, in coil, in water and in lab) concluded that the air circulation through the Canadian well-ventilated façade is provided only by the temperature difference that occurs in reality on ventilated façade channel direct sunlighted in summer. In winter, heat trapped in the canal, inside the building, can generate air circulation coil absorbs heat underground without a fan, as it appears in a Canadian well functioning documentation.

All this pre-heating / pre-cooling air systems in a ventilated façade can also be used to give maximum value in winter, to the exterior vertical garden made by one famos botanist, Patrick Blanc (fig. 5b) mainly for aesthetic reasons, and to improve indoor air quality in crowdly urban spaces or outdoors (Blank, 2012).

Mentioned is the fact that there are specialized plants that can eliminate certain types of pollutants and placeing them in a ventilated double skin façade (fig. 5a, d) can significantly improve air quality in the building. For example, according to (Purcaru, 2011, b) for a single day in an office, a species of ivy is able to remove 90% of benzol content and released by tobacco smoke, synthetic fibers, or dyes and plastics. Aloe vera, banana, spider plants and philodendron are effective against the agents of formaldehyde from insulation foam and particle board. Trichlorethylene in paints and glues is best removed with chrysanthemums and gerberas.

Speaking of these vertical gardens are not neglected energy efficiency qualities of buildings: protects against heat in summer and from cold winter. If these vertical gardens or other plant vertically growth systems as shown in the drawing system patented by Adams (Adams et al., 2012) (fig. 5c) would be placed between the glass walls of a naturally ventilated double skin façades with healp of one Canadian well, the results of energy efficiency, air quality and ventilation thus generated would be much improved. But energy efficiency results not only of this proposal can be confirmed by further research conducted for this purpose.

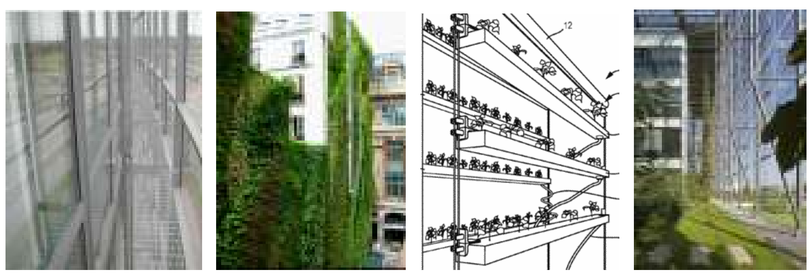

Fig. 5 – In order from left to right are: a. Picture inside of a ventilated double skin façades Blomsberg, 2007), b. Image of vertical garden attached to a parisian building turbot (Blanc, 2012), c. Detail of greenhouse with vertical plant growth system (Adams et al., 2012), d. Vertical gardens between two walls of glass (Marani, 2011)

CONCLUSIONS

In conclusion, natural ventilation in buildings, presented as complex system of Canadian well and ventilated façade, along with all methods and green technologies, including the presence and role of plants on blind walls or between glass façades can be harmoniously integrated in the design of complex buildings and their surrounding environment.

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