THE INFLUENCE OF NATURAL VENTILATION ON BUILT LANDSCAPE

INFLUENȚA VENTILAȚIEI NATURALE ASUPRA PEISAJULUI CONSTRUIT

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Abstract. *Strategies and methods for building ventilation, its location in a particular geographical area and climate, hygiene and comfort and their control by the occupants, are important elements that determine built landscape design. Volumetric shape and details of the building facade, coupled with exterior landscaping design, generate multiple benefits in the urban landscape, if designed judiciously. Although it is only a part of a building design, natural ventilation system contribute to its success and need to integrate harmoniously into the overall design of all built ensemble.*
Key words: thermal comfort, natural ventilation, climatic adptation of buildings, design of built landscape

Rezumat. *Strategiile şi metodele ventilării unei clădiri, amplasarea ei într-o anumită zona geografică şi climatică, condiţiile de igienă şi confort precum şi controlul acestora de către ocupanţi, sunt elemente importante ce determină designul peisajului construit. Volumetria şi detaliile de faţadă ale clădirilor, corelate cu designul amenajărilor peisagere exterioare, generează multiple efecte benefice în cadrul peisajului urban, dacă sunt proiectate judicios. Deşi constitue doar o parte a designului unei clădiri, sistemul de ventilare naturală contribuie la succesul acesteia şi este necesar să se integreze armonios in procesul general de proiectare al ansamblului construit.*
Cuvinte cheie: confort termic, ventilare naturală, adapatare climatică a clădirilor, designul peisajului construit

INTRODUCTION

In the most cases the buildings are ment to protect their occupants from the vicissitudes of the environment (extreme temperatures, wind, rain, noise, radiation, etc.), But also to ensure their proper indoor environment for their work and life daily. Buildings adaptable to their climatic location will be those that provide a comfortable indoor environment despite extreme external conditions. (Allard and Ghiaus, 2005). One of the most important factors that ensure comfort and indoor air quality is natural ventilation of buildings. Depending on the few main types of natural ventilation, we will illustrate below how this type of ventilation, orientation or location of buildings may influence their design and surrounding landscape.

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MATERIAL AND METHOD

Natural ventilation of buildings is based on hot air tends to rise, alowing the cold air to penetrate the lower part of the building. This phenomenon, called natural convection, is caused by temperature and pressure difference between inside and outside the building, also between two openings in the vertical plane of it. If the difference of temperature between the inside openings is greater than that from the outside then it creates so-called stack effect, air moving up as it warms and being evacuated trough the top opening of the building (fig. 1) (Lechner, 2009).

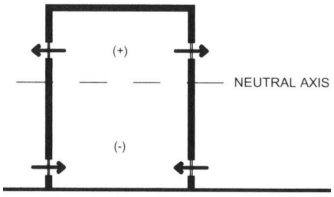

Fig. 1 - The difference of temperature cause the pressure difference causing vertical circulation heat (Lechner, 2009)

Wind is another factor that can determine the pressure difference, the building subject to wind action with a positive pressure, while the opposite is subject to wind uplift forces of wind, so with negative charge. Air moves from positive charge to negative charge, depending on the position and configuration of the building or through openings and / or its leaks or evoiding the building (fig. 2).

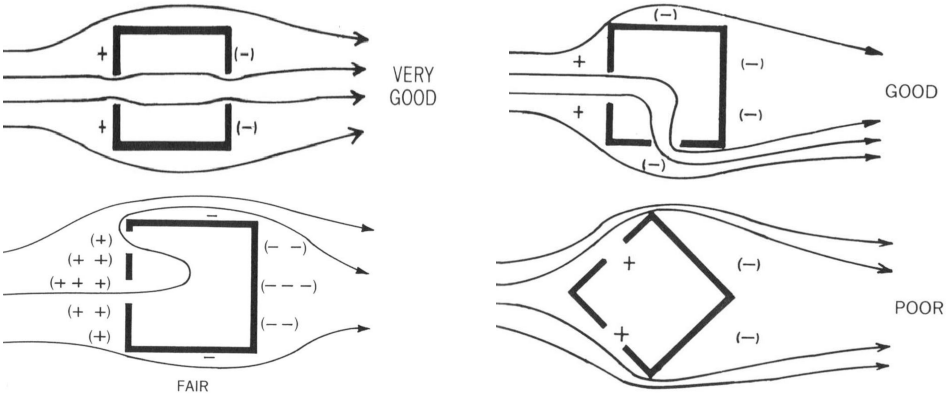

Fig. 2 - Depending on wind direction and positioning to building configuration, ventilation can be: very good (top left), good (top right), satisfactory (bottom left), weak (bottom right) (Lechner, 2009)

Bernoulli effect is another action, trough witch, growthing velocity of the fluid, determines its static pressure decreases. Because of this phenomenon thereis negative pressure in the venturi bottleneck area (fig. 3).

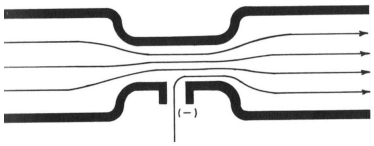

Fig. 3 - Venturi Tube (Lechner, 2009)

Ascending air velocity increases rapidly with height above the ground, so the pressure will be lower at roof ridge than that at the growndlevel window, so the air is evacuated through the roof opening (fig. 4).

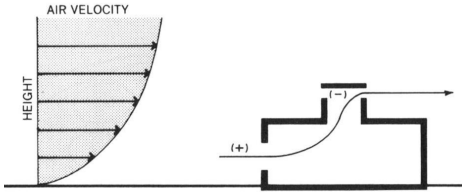

Fig. 4 - Bernoulli Effect: Air speed increases with height, and static pressure drops to roof ridge, so that the air is evacuated through the upper opening (Lechner, 2009)

The stack effect advantage compared with Bernoulli effect is that, it is not dependent by wind action, however has the disadvantage that it is very weak, which gives one very slow air movement. To maximize the the stack effect should be a maximum size of openings in the building envelope and a maximum distance as possible between them vertically. However it is more efficient to combine all these effects for better vertically natural ventilation.

RESULTS AND DISCUSSIONS

In buildings where one side ventilation or the cross ventilation is not enough, ventilation methods may be used, to improve ventilation rate, through solar and stack effect, in cases of no wind or too small temperature differences between inside and outside. Thus we can mention three such methods of ventilation with solar contribution (Gallo et al., 1988): Trombe wall (fig. 5), solar chimney (fig. 6), solar ventilated roof (Fig. 7).

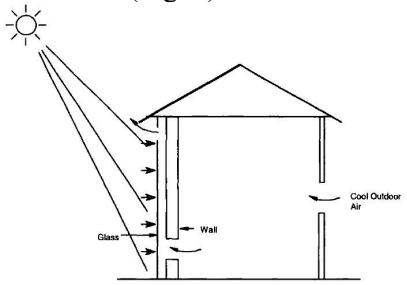

Fig. 5 - Ventilator Trombe wall (Gallo et al., 1998)

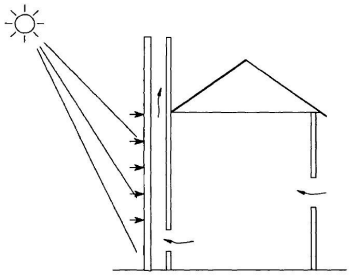

Fig. 6 - Solar chimney (Gallo et al., 1998)

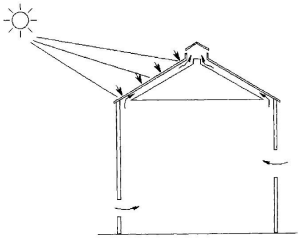

Fig. 7 - Ventilated solar roof (Gallo et al., 1998)

The Trombe wall is designed to heat indoor air in winter or to ventilate the room by enhancing the stack effect. An interesting application of stack effect is the solar chimney, witch, trough its location adjacent to the building, healp to avoid overheating of the interior, to accelerate ascension of hot air and exhaust it trough the top opening. The ventilated roof with solar contribution has increased efficiency due to Bernoulli and Venturi effects mentioned above. One very eficinte method to influence the ventilation of buildings is arrangement of various types of trees and shrubs in the vicinity of a building or group of buildings. The images in Figure 8 shows how two rows of trees oriented properly can channel air flow, more or less, to the building, thus enhancing its natural ventilation.

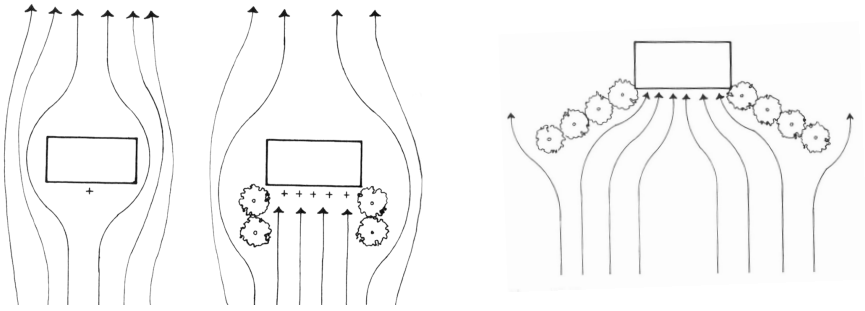

Fig. 8 - The influence of vegetation layout on the ventilation of buildings (Lechner, 2009)

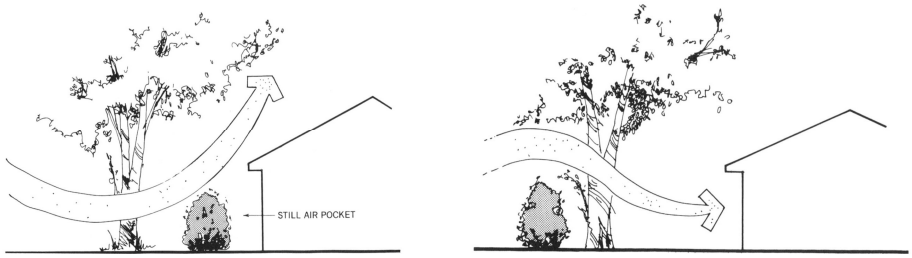

Fig. 9 -The influence of vegetation on the ventilation building layout: 1) favorable arrangement for the winter but unfavorable to summer ventilation (left), 2) arrangement favorable for summer period (right) (Lechner, 2009)

As shown in the figure 9 pictures, in the first case, the airflow of a prevailing wind can be deflected by the presence of bushes near the house, thus being favorable in winter. In the second case, bush location at some distance from building, beyond the tree strain, favorise air flow entering the house for better ventilation in summer.

In the same way, the dwelling location according to the presence of a lake or river can improve internal air in a dry warm climate, as the same solution may not be recommended in a humid climate.

An interesting example is the so-called "Fouggara" (in Algerian language), a transmission system using groundwater in desert areas of Africa. Figure 10 illustrates the structure and operation principle of this ancient irrigation system and to ensure permanent water.

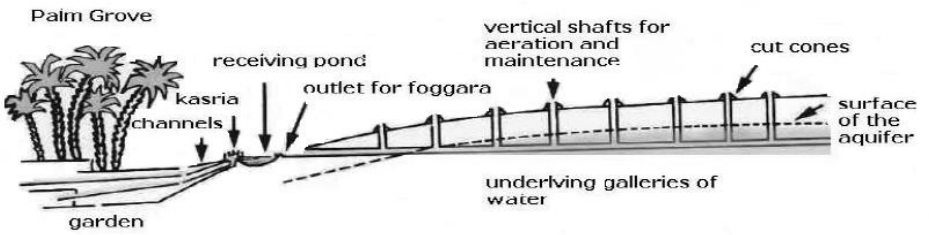

Fig. 10 - Fouggara gravitational system transporting water from underground channels groundwater to groundwater irrigated gardens in desert areas of Africa (Amara et al, 2011)

This underground drainage chenals system was related to a Canadian well and proposed, according to (Amara et al., 2011), to conditionate the air of a pilot building at a temperature of 21°C, the extent groundwater temperature in that channel. This would demonstrate the usefulness of an ancient, complex, but ingenious structure, which does not require any other charges than physical labor of those which have worked there, because there are 900 such systems in several countries in Africa, many of them abandoned.

Opportunity for summer cooling and winter heating through building design and surrounding landscape, existed in many forms, from ancient times,

being used successfully today, the subject being treated detail in a previous paper of the author (Purcaru, 2012).

CONCLUSIONS

In conclusion, natural ventilation in its various forms aims to maintain hygiene and comfort inside the buildings, since ancient times. Nowadays architects and plant engineers concluded that in most cases, is more economical but also more hygienic to use natural ventilation, with all its traditional methods of adapting to the climate Also the use of all possible environmental elements create a favorable environment to life and human activities.

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