Natural ventilation, efficient way to organize architectural space

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Abstract

With increasing environmental pollution in modern life and the creation of abundant allergies for human beings, improve the quality of the internal environment to reduce risks to human health has been considered. This theme in places with high population density, such as public buildings, administrative centers, educational, commercial, offices and etc, is more important, is the cause of succulence, alertness and performance of persons. Ventilation is one of the factors affecting the quality of the internal environment. This factor is possible with the different methods like mechanical, natural and combination. This article is a discussion about return to natural traditional ventilation, as a suitable solution for the modern buildings. Also that is mentioned as a factor for the organization of the architectural space and then classify the different ways discussed in advance this purpose.

Keywords: Internal space, Natural ventilation, Organizing of space

Introduction

Since human being always sought to adapt himself to his surrounding environment, the people in every region of the world endeavored to improve their living standards by employing the existing facilities and their levels of ingenuities. The unbridled increased energy consumption and uncontrollably employed technological instruments have left irreparable damages with destructed environment. Iranian communities particularly the inhabitants of hot climates have also initiates and invented procedures to cope with the considerably intolerable and in supporting head of air. A regard to architecture as being used a science with its primary aim to create a heaven or a shelter to make people immune from the damages and harms of some natural factors is especially important.

Necessity of internal environment quality

Modern world and changing the humans life types, is the cause of development buildings with high population density. so that, many people during their time spent in Administrative offices, commercial offices and ... in result, need to suitable spaces with the activities in that, is necessary, so that all factors causes the person, who can have the best performance. so this is mentioned as the quality of the environment.

improper methods in the design process often leads to the creation of a inadequate and inferior building. building material inappropriate and inadequate air flow are the factors that can put the health of users in risk. efforts to reduce energy consumption in the building, causing to reduce Air quality and unsuitable thermal conditions. thus the energy supply and provide a healthy internal environment must be considered simultaneously. (Olaf Hanssen, 2002, 6)

the purpose of monitoring internal air quality is providing comfort and the prevention of disease and negative effects on human health, although realization of it, is not possible for all people, because current population growth with the individual sensitivity always a percentage of risk is acceptable. the aim is, that the risk to people, especially people who are more sensitive, achieving to the lowest amount. the aim is, reducing this risk to the lowest amount for the people, especially people who are more sensitive, (Olaf Hanssen, 2002, 3)
internal air pollution also has the many effects on the economy, so that only the figure for Europe is estimated at 10 million euros per year. this figure corresponds to the human health costs and loss of income and production is due to illness. with this regard internal environment quality seems very important. in addition, perfect and appropriate environment for each activity, causes to increase the efficiency and economic growth of community.

Factors affecting the quality of the internal environment

What users need to maintain a safe environment, in different places, including workplaces, public spaces, schools, daycare, restaurant, hotel, cinema and ... Is different. a safe environment to the needs of all people, both healthy and high-risk groups (children, elderly, people with high sensitivity) that are more sensitive than the average man, is accountable. (Olaf Hanssen, 2002, 10)

The quality of the internal environment is often considered synonymous ventilation. but the ventilation is only one factor, although it is very important. factors such as building material, activity in building, pollutants, temperature, humidity, light, noise and ... Can be influential in the environmental quality. identify the factors affecting the quality of the internal environment can help us in designing appropriate buildings. these factors include:

- the thermal masses encompassing the building
- the atmospheric environment of building (particles that are transported through the air, bacteria, viruses, fungi and voc, etc.)
- acoustic field (noise in and around the building and how to controlling it)
- radiation field (lighting, electromagnetic radiation, radon, etc.)
- mechanical environment (shape of room with its existing equipment)
- aesthetics factors of the building (decoration, environment design, paint and walls, etc.)
- psychosocial and social environment (type of work, amount of work, supervision on work ...)

Review of Ventilation quality as one of the factors affecting in the internal environment

Ventilation for purifying, pollutions generated by the building material, and human and activities in the building is essential. ventilation systems should be base on the needs and demands of users and on the base of the rules, information about the activities that will be done, and human types that they use (employees, elderly, children, people with high sensitivity, etc.) are planned. for entering enough air for the ventilation, heating and cooling ventilation systems should be considered separately. this means that ventilation requires its own calculations. And should be studied as an independent agent. (Olaf Hanssen, 2002, 16)

Three ways solution mainly for ventilation should be considered. (Olaf Hanssen, 2002, 16)

- mechanical ventilation
- natural ventilation
- the combination ventilation

Each of these three solutions have advantages and disadvantages in the following. mechanical systems are very easy in operation and the amount of air can easily be adjusted according to user needs, but due to bad planning and system design and maintenance problems, the use of this strategy is often not pleasant. natural ventilation in buildings with high population density, is not sufficient. natural ventilation is caused by pressure or temperature difference, that its level is very high in winter and very low in summer. another factor is also input the amount of pollution that comes from lack of clean outside air, this can have negative effects on human health. thus the natural ventilation alone may not be responsive. combined ventilation is obtained by combination of the two solutions. so that, when natural ventilation does not work as well, fans are activated automatically. so perhaps a combination system is the best solution for building ventilation. (Olaf Hanssen, 2002, 16)

Natural ventilation

Before the invention of modern mechanical systems, all buildings were naturally ventilated. with the development of these systems, architects and engineers, replace the mechanical ventilation instead the natural ventilation. fresh air deficits after decades causes to the lack of communication with the outside environment and lack of personal supervision to the environment, negative psychological effects, and physical and emotional problems was. windows in modern buildings had lost their old meaning. (http://scholar.lib.vt.edu/theses/available/etd-05222001-110045/unrestricted/05BKnatv.pdf, 12pm 5/1/2008, 38-39)

In the past few years actions for fusion of the Natural ventilation to artificial environment was done. fresh air, like fresh water are the basic needs of human. when the working and living environment ventilated naturally,
humans are more healthy, they work more and effective and have a greater sense of belonging to their environment. ventilation is very important, especially in educational environments. natural ventilation creates an environment with dynamic air and water. conditions is not possible with mechanical ventilation, and this causes students to be conscious. on the closed environment, especially in cold seasons, that the buildings need to warming, the lack of natural ventilation can be causes to spread diseases such as influenza. in these days, due to lack of suitable ventilation in modern buildings, People become sick. headache, fatigue, shortness of breath, sinus diseases, cough, irritation of nasal and eyes and throat and skin ... There are many such.

**Historical Background**

how natural ventilation in old buildings, can help us to find solutions for the modern buildings. natural ventilation using wind as a natural energy, made the form and framework of architecture integrated with nature, this mostly seen in ancient architecture. human beings have always tried to adapt to their surroundings, and humans in different regions of the world have tried to improve standards of their life with using existing facilities, in fact these buildings were committed on the sustainable design principles in their era, with the assumption that a building or structure is a small part of our natural surroundings and therefore should act as part of the ecosystem and located in the cycle of organisms. so it can be remembered as a intelligent building. (Mahmoudi Zarandi 2006 -1)

Word ventilation (ventilation) has a Latin root (venture) means relocation and moving air. ( Mahmoudi Zarandi 2006 -2)

Air conditioning (ventilation) is a process during that the air of the inside of a building can be replaced by fresh air or in other words to exchange or swap the outer and internal air flow. In the absence of any other air facility is not used, and without use of alternative energy is called ( Mahmoudi Zarandi 2006 -2). the use of natural ventilation in the old Iranian architecture is found in abundance.

Wind catchers have a traditional structure in Iranian architecture. this vertical canal is composed by two parts inter channel cross section begins from the roof and find the way to the spaces of building and exterior part, including vents for entering of wind, thats located on the roof. this structure with using the suitable wind, change the air temperature of inside (Figure 1) ( Mahmoudi Zarandi 2006 -2).

The other structure is a Kolah farangi is the vent that embedded on the vaulted roof as well as air conditioner and the skylight, has been used for space of under the arch. when the wind passes through a spherical surface, that owns the maximum speed (more than anywhere else). at this point the pressure is reduced according to the Bernoulli effect. accordingly, the pressure difference created between the air inside and outside, suction created and the fresh air, replacing with inside air of building, from the underneath vents (Figure 2). ( Mahmoudi Zarandi 2006 -2).

In traditional buildings in Saudi Arabia (Malkef) as the most important element that provides natural ventilation can be seen. this structure, enter the fresh air, and send out the air of inside by a chimney or a central courtyard. (Figure 3). other structure in the traditional architecture of Saudi Arabia is (Moucharabeih), that is a cultivar wooden opening and thus the small openings within it causes to natural ventilation. sometimes with

![Figure 1. Natural ventilation in Iranian architecture (Tavasoli, 2002)](image1)

![Figure 2 Kolah farangi in Iranian architecture (Mahmoudi Zarandi 2006 -3)](image2)
putting a pitcher of water against air flow within, evaporative cooling occurs. (Figure 4)( Mansouri, Yasmine · 2003 · 815)

Effect of major factors in the natural ventilation systems old natural ventilation systems, all based on tried-and-error process are obtained. but advancing technology bring us new elements that makes natural ventilation techniques evolution. these are the basic factors of natural ventilation systems (Mansouri, 2003 · 816).

- select suitable method of natural ventilation based on position, climate
- the suitable form of building to have the best access to outside air.
- the orientation toward the suitable wind and Floating Forces on the site.
- optimal proportions of input and output openings for receiving or depreciation of air flow to achieve natural ventilation objectives.
- exponential and the proportions of the interior spaces, to enter the space as their needs are a priority for the normal member.

The natural ventilation a factor for the organization of architecture space

An overview of the natural ventilation buildings shows that these buildings are each one of its kind have certain principles. thus the selection of appropriate ventilation strategies in addition to fulfilling the needs of each climate has caused the formation of organized spaces. the natural ventilation techniques based on view of morphological (shape) are classified. these methods include the distribution of space, the chimneys effect, ventilation shafts and reciprocal openings (Mansouri, 2003 · 816).

The ventilation by the distribution of space (transitional)

this ventilation strategy based on the use of a space distributor, including Atrium or vertical staircase. (Figure 5) in addition to natural ventilation transitional space is a place for relaxation and rest, or Communities people which plays an important role in organizing the rotation of spaces (Mansouri · 2003 · 816).
As mentioned earlier, ventilation strategy by the space of distribution on the design of building is very effective. So spatial organization of the components depends on the position, number and correlation of distribution spaces. Three major organization factors are possible (Figure 6) (Mansouri, 2003).

Indented structure: Building ventilation distributed in the different air spaces. (Unrelated)

Adjacent structure: Building ventilation system contain more than one space is distributed. Link between distribution spaces increases the rotation of temperature. (Unrelated link)

Conforming structure: Distribution spaces are compatible in some parts with each other. So the ventilation strategies affect on the whole of organization spaces (Mansouri, Yasmine 2003).

Figure 6. Three major organization factors (Mansouri, 2003).

Ventilation by the chimney effect the most common form of this method is a simple chimney that for the various buildings are different. Method of natural ventilation of chimney is not combined with the framework of building, therefore does not affect on organization of building spaces, for this reason, the

Figure 7. Ventilation by a chimney effect (Mansouri, 2003).

Emergency exposure position of the system are unimportant. Figure 7 shows how spaces of building ventilated by a chimney in the front of building. This system also with a suitable design can act as a windward (Mansouri, 2003).

Several spatial proportions in this style on the yield of building is possible (Figure 8) which include:

Adjacent structure: Each space separately ventilated this means, air enters from one side and exit from the separated chimneys in each space. (Independent of geometric spaces)

Conforming structure: All spaces are conforming each other in some parts. While each space has a special ventilation strategy. (Independent of geometric spaces)

Appropriate structure: Spaces with the same design are conforming with each other (depending geometry of spaces). So that air enters to each one and discharged only by one chimney.
Ventilation by the ventilation Shaft

Ventilation shafts are combined with the building shell, therefore most of them are involved in the building structure. In other means building design is dependent upon the ventilation needs. For example in (Figure 9) position and organization of the spaces, have been affected by natural ventilation requirements. The size of ventilation shafts and location of spaces, are dependent to strategy of ventilation. Spatial organization of the building significantly is dependent to the ventilation system and concurrent requirements of ventilation system, design the shell of building.

from architectural point of view, there are two possible solutions for the arrangement of spaces. (Figure 10) adjacent structure: each space separately is included ventilation shafts (independent of geometric spaces) appropriate structure: spaces by using only one shaft, ventilating and unsuitable weather is eliminated by another shaft. (depending geometrical spaces)
Ventilation by the Mutual openings

several techniques developed from ventilating in the two shells facades, thus, ventilating based on design of the openings formed. this strategy especially respond in temperate climates. famous example of this buildings (commerzbank) is Norman Foster (Figure 11). offices in the outer shell, the air needed to breathe through the outer section which is composed from two layers of glass fixed page, they receive directly from outer space. internal plate is a double opening that can be opened from above to inside. the outside air by the glass openings, enters to the outer shell. ventilated spaces necessarily based on the design of buildings outer shell and the position of openings in the facades of buildings.

Figure 11. Interaction openings in commerzbank building (Mansouri, 2003, 818)

Natural ventilation with this strategy can be estimated with the two strategies. the connection between self-ventilated areas and outer areas is concerned (Figure 12). These are:

Adjacent exterior: in this case, the spaces ventilated in the shell of building structure are located so that, its in relationship with the outer space.

internal proximity: building spaces by the transitional space that enables connection with the outside, are ventilated.

Figure 11. Two strategies of Mutual openings (Mansouri, 2003, 818)

Conclusion

Use the space under the roof slope as in the distribution space in building attic space often is a useless space. this space, especially in temperate and humid climate, needs for ventilation and does not cooperate in the internal spaces ventilation. with an overview of natural ventilation techniques can be concluded the attic space can be described as intermediate space between the main building and the outside environment to be considered and has a function similar to the distribution space. in addition, the space with other space, which also acts as a chimney and the suitable wind receiver, are combined and therefore allow better ventilation for the building has created. in the following, diagrams is given of how it works.
Figure 13 shows how building acts during the cold season. In this figure, a sloped roof with transparent photovoltaic cells with a suitable slope (latitude +10) is covered. Thus, in addition to the power supply causing the greenhouse effect, there is also an attic space. In the roofs of the main space, some valves are embedded that allow warm air to enter the space from below. Figure 14 shows how the building is ventilated in the cold season. Thus, unpleasant air goes out through the chimney and wall vents.

![Figure 13. The action of building in cold season (Authors)](image1)

![Figure 14. The ventilation of building in cold season (Authors)](image2)

Figure 15 shows the building in a warm season. Thus, due to the absence of the greenhouse effect, the transparent part with a thick coating (external space) is covered. The vertical element receives the optimal wind. This wind, after passing through the spray water cylinders cooled and by wall vents, enters the space.

![Figure 15. The action of building in warm season (Authors)](image3)

Figure 16 shows that if the building in warm season needs to be ventilated, this action is possible through opening of ceiling vents. Thus, the fresh air enters from below and the hot and unpleasant air goes outside from above and to the intermediate space and then goes outside by the wind catcher openings.

![Figure 16. The Opening the ceiling vents for ventilation in warm season (Authors)](image4)
Figure 17 shows that both spaces, also chimney space and attic space can act as a space ventilation in temperate seasons. In this condition vertical element with creating suction ventilate the space. Figure 18 suggests that this deformation of the curved roof according to Bernoulli effect, can cause more suction in vertical element and so, space ventilation will be better.

References


