

680: A modern use of cooling systems being used in Iranian traditional wind-catcher (*Ba'd-gir*)

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Abstract

One of the basic necessities in designing and construction of buildings is to devise a ventilation system. As a result of technology development and making use of fossil resources of energy, this need is met broadly through utilizing mechanical ventilation systems. However, regarding the increasing use of energy and the ecological crisis threatening the environment more than ever, it is necessary to take the use of clean resources of energy into consideration more than before.

Considering the fact that one of the main characteristics of Iranian traditional architecture is being responsive and consistent to the climate, making the best use of renewable energies, such as solar energy, and wind for heating and cooling the buildings. The strategies used by Iranian architects for handling air flow in buildings show their proficiency and creativity in using natural energies. Therefore, nowadays, the Iranian ancient experience in the use of natural energy of wind for cooling buildings can contribute to the development methods and exploitation the renewable energies and its potentialities compatible to new and modern lifestyle. In this paper, the features and the functional principles of natural ventilation systems for cooling the buildings is studied, and then the application of wind-catcher as a masterpiece of Iranian traditional architecture will be analyzed. Based on the derived ideas, methods and strategies is suggested for the application of natural ventilation in buildings, during hot season in different regions of Iran including hot-humid and hot-arid regions.

Keywords: wind-catcher, passive cooling, natural ventilation

1. Introduction

One of the most significant features of traditional Iranian architecture is the special architectural specification in various climates, which make each region distinct from the others. Investigation of different Iranian regions indicates that in past, different techniques and methods for controlling and making air movement in interior space of the building were common. For instance, one-layered arrangement of buildings in the southern coast of Caspian Sea, and coasts and islands of Persian Gulf and Oman Sea, windows facing the wind and facing backward the wind in both directions or in different levels in buildings of the southern coast of Iran, wind towers in cities like Kashan, Yazd, and roof windows in most regions. Unfortunately, development as an impact of facilities industrial progress, cooling and heating with the assistance of using fossil fuels, meanwhile the change in life-style have made living in traditional houses difficult. Making use of clean energies and renewable resources have been widely ignored or taken for granted. On the other hand, considering the rich background of Iran in using natural energy of wind as cooling, by using these methods in a modern way and consistent to modern life, paves the way to take the benefits of wind energy efficiently. In this paper, first natural ventilation systems such as wind-catchers (wind towers), will be briefly discussed and considering the principles and fundamentals of how they work, methods for increasing air flow, natural ventilations of modern buildings will be presented

in order to save the energy used in cooling, in buildings.[1]

2. Natural ventilation systems in past

Natural ventilation has been used since 2000 years ago and its base is the air movement and flow inducted by the difference in the (inside and outside) pressure and temperature, such as the wind catchers used in Iran [1]. Wind catchers have been in use since a distant past and are one of the particular Iranian master pieces in conquering the severe conditions in hot and arid regions (fig 1).

2.1 Function of a Wind-Catcher

Function of the wind catcher is based on the wind blow for transferring the desired air inside and from its reaction, suction, for letting the warm air out [2, 3]. The main factor in air flow in a wind catcher is the gravity with no need for using a fan. If we use a fan, size of the wind catcher will be decreased.



Fig.1 Vernacular materials is used in wind-catchers

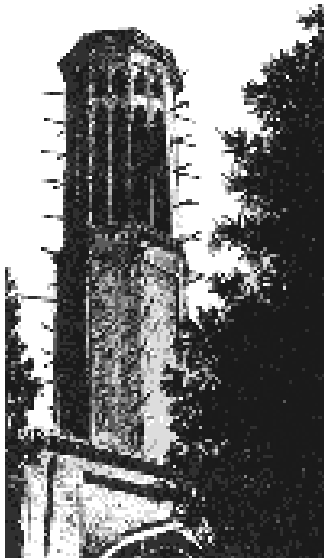


Fig.2 The tallest wind-catcher of Iran in "Dolat-abad" garden

Usually in the entrance of the air to inside, wet straw is installed So that the rather dry air evaporates the water and cools the air passing through the straws. Cool air is heavier than the warm, so descends and the air is circulated in wind catcher.

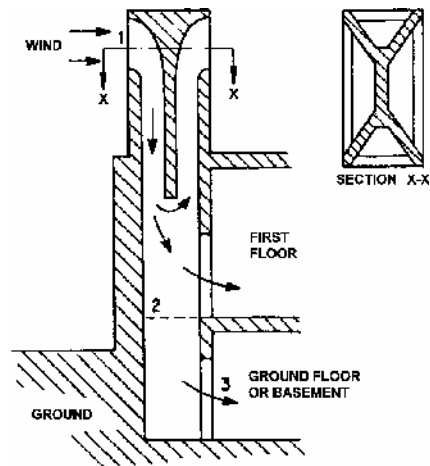


Fig.3 Air flow pattern in a conventional wind tower

Fig. 3 shows a cross section of a typical design of a conventional wind tower [4]. For the new designs of wind towers, we considered two designs, which eliminated the disadvantages listed above. These designs were called:

- (1) the wind tower with wetted column, or wetted curtains, and
- (2) the wind tower with wetted surfaces .

The tower head in both designs was equipped with screens at all openings and plastic curtains behind them to allow only the air to enter the tower from the outside, and prevent the air from leaving the tower from that opening.

2.2. Size of a wind-catcher

Common wind-catchers are mostly located on the roof and their height varies from 10 to 15 meters. If the wind catcher is higher (i.e. the distance from entrance to the exit) the pressure difference will be higher. Wind causes walls facing the wind make positive pressure and the walls not facing the wind cause negative pressure. Therefore, the fresh air from the wall facing the wind enters and exits from the others [4].

2.3. Materials

Using the vernacular and simple materials in building the wind-catchers the other specification. These materials are totally brick and mud and for reinforcing the structure against wind wood timbers are used, which also result in a special view of the structures in city context. (Fig. 1)

2.4. Wind-Catcher in Iranian traditional Houses

In Iranian traditional houses, wind-catchers are exactly located on top of "Houz-khane", (a filter between yard and summer rooms with a shallow pool) and air flow is conducted on the surface of water of the pool. [2, 3]

3. Taking the benefits of old patterns

It may not make sense to use wind catcher as the natural ventilation and cooling as the other system these days. But using the principles and methods of how they work can teach us to develop methods that encourage less energy use for efficient cooling. Generally, wind blow and air movement in the spaces with the assistance of the windows provide air flow in the building. The important factor to be considered is the direction of wind according to the windows. (Fig. 4)

Generally, arrangement of windows in the plan of the building shouldn't be concentrated in one side. The best place to install the windows is in the farthest sides from each other. Application of the overall ventilation is the most efficient strategy for natural cooling.

In general, considering the following principles can help efficient use of natural ventilation.

- Air flow in building should be continuously circulated.
- In crowded spaces, air flow should enter the space directly.
- The location the building in sitting and walking areas should be installed less than 1.5 meters from the floors. [1, 6]

4. Suggestion for the application of natural ventilation system

4.1. Location of the Openings

Special attention to the function of wind catcher shows that planning the places, where air enters and exits should be in direct and opposite direction of the wind, respectively and there for, is an important factor in using the natural ventilation.

In modern buildings this concept can be used as following:

In cases where a building has windows and wind enters through them a canal can be installed on the opposite side to capture the radiant energy of the sun.

Therefore the warm air move upward and passes through the holes near the roof of the canal. As shown in fig5

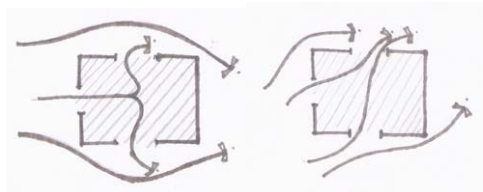


Fig4 The performance of the fenestrations in buildings ventilation

4.2. Green Space

In cases where the green space in direction of the wind is used, the following important

advantage is realized to naturally ventilate the buildings.

First: Green space induces pleasant breeze entering the building.

Second: in case where the windows are located near the trees, the tree shade will cool the adjacent air which will be conducted in to the building.

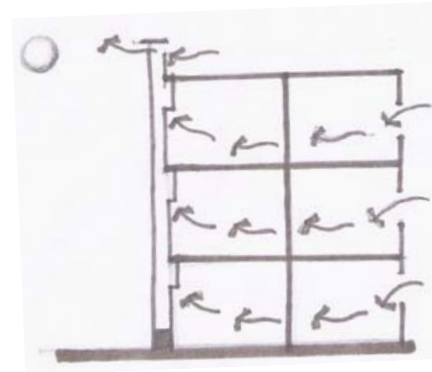


Fig5 Natural Ventilation through fenestration facing wind and installation air-sucking canal on the side with the maximum sun rays

4.3. Vertical ventilation

One of the methods that are applicable in urban building is "vertical ventilation".

When it is not possible to place the window to face each other preventing the air flow to pass through the building roof shutters or central staircases can be installed to increase the overall ventilation and or vertical ventilation.

The most important principle in natural vertical ventilation of a building is the differences in air pressure in lower and upper parts, causing heat convection to upper parts. [3, 5]

4.4. Solar wind-catcher

One of another way to cool building is the combination of solar chimney and wind catcher.

The solar chimney with portable glasses when combined with a catcher together in tandem is called solar wind catcher.

When the sun is shining, the solar wind-catcher is heated up and a small turbine placed on top of the wind catcher, causes the warm air inside to be conducted out of the chimney. In this case by opening the shutter in the northern part, fresh air enters the building and ventilation is accomplished. [5, 6] (Fig. 6)

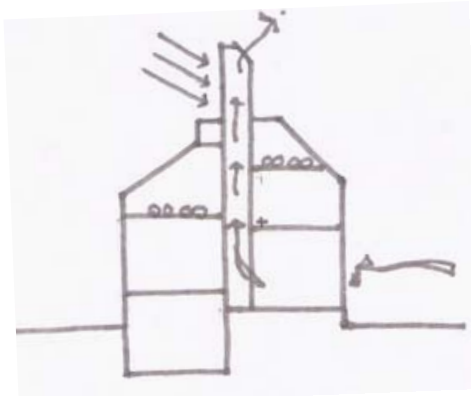


Fig6 A section of a solar wind-catcher

5. Conclusion

Mechanical ventilation systems not only consume significant amount of energy but also may cause environment pollution.

Iran has special geographical and climate features conducive to receiving significant amount of sunshine and wind these conditions if used properly, can significantly reduce the energy use and provide proper ventilation for the buildings. Current research shows that by taking advantage of previous experience, it is then possible to use natural ventilation systems or even in combination with simple mechanical systems (i.e. fan) to reduce the energy use.

The energy source for the fan can be provided by installing solar panels in appropriate places in order to significantly save fossil energy.

Therefore, nowadays, the Iranian old experience in the use of natural energy of wind for cooling buildings can contribute to revive these methods and exploit the eternal energy and its potentialities compatible to new and modern life style.

In summary the following methods are recommended:

- Design and implementation of opening in building.
- Combination use of ventilation and simple mechanical systems (i.e. fan) utilizing solar energy.
- Installation of opening in the direction of the wind and installation of canal for transferring warm air in the direct of the sun.
- Transfer of stored heat from inside to outside of the building.

6. Acknowledgements

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