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Research Article

WIND POWER; DESIGN CONCERNS OF ARCHITECTS OF PAST AND PRESENT

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ABSTRACT

All climate and environmental conditions, such as the sun, wind, humidity, terrain etc. have long directly influenced or traditional architecture.The windcatcher, for many years and in many cases was deemed as the only possible solution to enduring harsh weather conditions of hot and dry parts of Iran's central plateau and outskirts of Persian Gulf, and was considered as a component of Iranian homes' structure, a component that effectively creates a pleasant air condition by adjusting the wind and utilizing evaporative cooling. Windcatchers are among the historical elements of Iranian architecture, and seen as an important innovation in aboriginal architecture. These elements, which are designed with a climate-based approach, are known as a static cooling system that provides air conditioning by utilizing the renewable wind energy. Windcatchers not only help with environmental goals, but they are also seen as elements of aesthetic beauty in the buildings.While with the emergence of modern architecture and the use of advanced mechanical air conditioning in buildings, the role of climate and elements such as windcatchers in Iranian building design has dwindled. The use of windcatchers, and modeling its structures, has expanded in architecture all over the world in places with warm, dry and mild climates, but barely anything is being done about it in Iran, the cradle of windcatchers, but looking back to past and praising it, due to many reasons such as a lack of concern for the efficiency of elements of old architecture and not attempting to fix its possible errors of design. It must be emphasized that utilizing sources of natural energy such as the sun, wind and water, not only decreases fuel costs, but can be also be seen as a project with long-term goals to preserve the environment and achieve sustainable development.The study method is descriptive-analytical, and case-based. In this study, we attempted a comparative study on Iran's windcatchers, especially the windcatchers of Iran central plateau concerning their structure and form, and compared the strengths and weaknesses of these outstanding elements of Iranian architecture,and provided suggestions to fix its problems and improving its performance and also updated this architectural element.

Keywords: *Wind, Climate Design, Windcatcher, Sustainable Development*

INTRODUCTION

Windcatcher is one of the most important creations of Iranian architects with a climate based approach in the architecture of desert regions and their outskirts reaching till the Persian Gulf. Windcatchers, as a vertical canal, in addition to their beauty, have a considerably important role in naturally ventilating the internal space of buildings. Iranian architects have utilized the basic principles of thermodynamic, aerodynamic, heat transfer and strength of materials.

Seasonal and daily winds are one of the main characteristics of desert regions of Iran, and windcatchers are created with these winds in mind. Valuable examples of windcatchers can be seen in all desert cities of Iran and outskirts of Persian Gulf, such as Kashan, Kerman, Yazd and etc. which are in fact the originating places of windcatchers.

The creation of windcatchers has been prominent in Iran ever since the first lunar periods, and it was rather common in other countries, close to or far from Iran, to use this important element of architecture (Bahadori-Nezhad, 2008). The importance of windcatchers in Iranian architecture has manifested itself in different literarytexts and orientalists' and travelers' travelogues.

In Iran's desert regions, domed roofs and pergolas are used besides windcatchers in order to improve their performance, increasing the power and efficiency of windcatchers to naturally ventilate the building.

Nowadays, alarge part of energy consumption of buildings is allocated to ventilation. In advanced countries, there seems to be a considerable attention paid to natural heating and cooling system to obtain a sustainable development. Traditional windcatchers are one of the best methods of natural ventilation.

The Structure of Windcatcher

Windcatchers are vertical towers with tetrahedral or polygonal structures, which are higher than other parts of the building, and are usually placed in a space called spring houses.

From a geometrical point of view, windcatchers are divided into some general categories:

Figure 1:Windcatcher with Vertical Rack – Source: Author

*Cubic Windcatchers:*Most of Iran's windcatchers belong to this category. These windcatchers are named based on the number of their entries and the direction they are facing; one-sided, two-sided, three-sided, and four-sided windcatchers.

Two-Story Windcatcher

Figure 2: Two-Story Windcatcher of Aghazadeh of Abarkooh's House

There are a few numbers of this type of windcatcher in Iran. The lower floor is considered as a foundation for the higher floor, and the second floor is smaller than the first. The reason of using this type of windcatcher is to reach a greater height and utilize the wind more efficiently.

Polygonal Windcatcher (Hexagonal and Octagonal)

These types of windcatchersare usually built on top of cisterns, and are barely used in residential buildings. They can receive wind from all sides due to having openings. The windcatcher of Yazd's Dolat-Abad Garden belongs to this category.

Figure 3: Polygonal Windcatcher of Nayin's Cistern (Source: Author)

Windcatcher with a Circular Plan

Windcatchers with circular plans are rare examples of windcatchers in Iran. The most prominent of them is the windcatcher of Ardestan'sSarhang-Abad Garden, which has been built with a circular plan in both stories. The two windcatchers of Bede-va-Bostan in Kashan have also been built with a circular plan. The main blades, in this type of windcatcher, are in line with circle's diameters (Mahmoudi, 2009).

Figure4: Ardestan'sSarhang-Abad Windcatcher

Domed Windcatchers

Domed windcatcher, or pergolas, are usually placed on top of spring houses, and are used to improve the performance of windcatchers. The pergola of Khane-ye-Boroujerdiha is one of the best examples of this type of windcatcher.

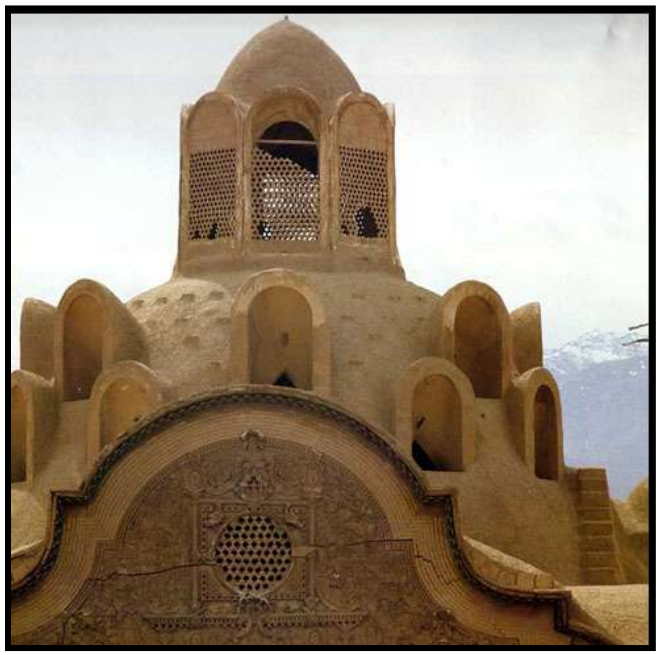

Figure 5: Domed Windcatcher of Khane-ye-Boroujerdiha in Kashan

The windcatcher's main canal is a rectangular cube shaped duct which is made of clay, brick, mud mortar and an external layer of thatch. However in many instances the external layer is made of chalk. Wooden beams, made of mulberry wood and resistant against termite, are placed inside the canal walls. These wooden beams are the structure of the canal. Windcatcher canals of Yazd, with vertical blades are split into sub-channels. Sub-channels, based on the format of blades' placement can be prism-shaped or rectangular cube-shaped. If the blades are placed cross and with an angle, they can create other prism-shaped canals. Sub-channels inside the windcatcher, considering the form of the plan and form of the main blades, are seen as six horizontal cross sections below.

In most cases, windcatchers have scaffoldings which connect the walls of the windcatcher, and the two sides of this scaffoldings point out from the sides of the windcatcher. The mentioned scaffolds are installed in order to increase the resistance and hardiness of windcatchers against the wind, and their tensile role prevents the spokes from cutting loose.If wooden elastics have enough thickness, the two ends of them that are sticking out can be used as scaffolds for mending the windcatcher (Farokh-yar, 2007).

The Disadvantages of Iranian Traditional Learnings

Traditional learnings have certain disadvantages and shortcomings that must be investigated and fixed if possible, in order to be able use this valuable element again. Some of these disadvantages are mentioned below:

- The temperature of the wind that enters the windcatcher is equal to outside temperature. For example, the temperature of a summer day can't bring comfort to the building's inhabitants.
- The effective factor in reducing the air temperature in windcatchers, is the coolness of air at night and saving it in the building mass. And since this amount of saving is not much, all of it would be depleted in the first hours of day, and the windcatcher cannot meet the building's needs in war seasons.

- In the case of lack of wind, windcatchers cannot provide the needed wind to make the air flow. In this case, only in the first hours of the day a little amount of wind enters the building, and in the rest of the day the windcatcher acts as a chimney and removes the air inside the building.
- In some regions, due to not having a certain direction, multi-directional windcatchers are used in order to have a favorable wind. These windcatchers cause a certain amount of the intake air obtained from the canals to exit from the other canals of the windcatcher and waste a large amount of the intake air. This does not happen in one-directional windcatchers.
- In buildings that the windcatcher starts from underground and the intake air reaches the underground, even with the passage of air on damp surfaces and through waters ponds, the reduction in air temperature is still low.
- Dust, insects and small birds enter the building through the entries, especially in warm seasons of the air, and disturb the inhabitants.

With the smallest of changes in the structure of the windcatchers, and minor fixes, most of the problems can be taken care of, and still use windcatchers as important elements in naturally ventilating the building.

For example, with installing filters in front of windcatcher entries, dust and incest entry can be prevented altogether. Or by installing a circulating disk, the air leak problem can be addressed. Yet, the point must be considered that the installed system must have a spontaneous and mechanical performance, and be sensitive to the blowing of wind.

The problem of lack of wind blowing, can be addressed by combining windcatchers with a solar chimney system, or, by considerably increasing its efficiency by using wet-able columns or surfaces.

Windcatchers in Modern Architecture

With the emergence of advanced mechanical facilities in architecture, the role of native and climate based architecture with the use of elements in harmony with nature slowly faded away. But with the everyday increase in energy consumption, a lack of renewable energies and fossil fuels, extreme environmental pollutions and endangering the whole planet, gradually attention was paid to designing climate friendly buildings using clean and renewable energy.

One of the possible methods to reduce the consumption of fossil fuels, is to use clean energy, such as solar energy, wind and water, in order to provide heating and cooling systems and also natural ventilation for the buildings.

For architects, wind is considered an important element in building design. By changing the heating transaction of a building, – either because of convection phenomena, or due to infiltration of air into the building – the element of wind has a considerable effect on the matter of "thermal comfort". Better understanding of the behavior of the wind, especially that how the local positions of wind can affect the given building, is crucial in efficient execution of the building in the eye of climate and weather conditions (Ahmadi-Nezhad and Mohammad, 2002).

Windcatchers in fact represent the simplest method possible for utilizing natural ventilation, and they have been considered by modern architects and eco-friendly designers, by implementing the unique structure of them as patterns for designing vents and shafts in buildings.

When wind is blowing and is in motion around a building, it can cause natural ventilation. It is easily possible toprovide conditions for receiving and driving out the air and creating ventilation by elements with structures that have pseudo-windcatcher characteristics.

All designs of badkhans and windages are based on old schemas of windcatchers in Middle East and Iran. In their design, local characteristics and conditions, the form and structure of the building, the need of the users and the expenses are considered, which causes an increase and improvement in building's ventilation. In new designs, by causing maximum pressure difference between the air inlet vents and chimney effect, ventilation in these buildings is created.

Byembedding windcatchers, the possibility to ventilate in order to provide simultaneous fresh air and removal of excess air, without the problems of maintenance and costs related to a multi-purpose tool, becomes available (Ahmadi-Nezhad and Mohammad, 2002).

Blue Water Emporium, Dartford, England

This is the building of the Emporium, in which the designers have sought to eliminate air conditioning and utilize natural ventilation. In Blue Water Emporium, air is provided through a series of conical windages which are based on traditional Kent houses.Windages are designed so that they rotate around a vertical axis in the direction of the wind blowing.Also, certain types of blades have been utilized in its design that are exposed to wind in case of fire.

Figure 6: Blue Water Emporium

Queens Building, Lister, England

The amount of energy consumption in Queens building, is two third of the energy consumed in an ordinary building with a proper design of natural ventilation, and half the energy consumed in a similar building in which air conditioning has been used (Ahmadi-Nezhad, Mohammad, 2002).

The out of ordinary structure of this educational building is such that fairly substantial volumes have been created in it by thin cuts. The building contains three aspects of windages. In summer, parts of this building is ventilated using these cuts. Other openings are provided in other parts of the building that cause drafts.

The hot air generated in this building moves upwards, and exit through pyramid chimneys that are placed 3 meters above the building. The direction of the air flow is not limited in this building.

Figure 7: Queens Building

CONCLUSION

Typology and diversity of windcatchers in Iran showcases the ingenuity and creativity of Iranian architects, stating that they considered the functional aspects of architecture too in addition to aesthetic aspects of architecture.

Unfortunately, the use of windcatchers has dwindled in the country. In our country, windcatchers are seen as old and non-functional systems, which are no longer able to compete with modern system, or due to certain reasons are not willing to change its structure. And all the while, modern countries are modifying this system as an eco-friendly system that is able to reduce pollution and energy consumption, and its uses are becoming more widespread every day.

How to use this technology in a new way can be an important research case for Iranian architects. All the while other countries are leading in the matter of studying Iranian architecture, and register its new forms in their own name and utilize windcatchers as supplements to air conditioning and cooling systems of buildings.

Such elements are not rare in Iranian architecture, such as aqueducts, and water dams; and still new horizons and achievements can be obtainedin a sustainable development approach, by energy saving and a climate based approach in architecture. We must notice that in case of carelessness and neglect of these precious monuments, they shall slowly fade away and be forgotten.

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