The International Journal of Engineering and Science (IJES)
|| Volume || 13 || Issue || 9 || Pages || PP 334-339 || 2024 ||
ISSN (e): 2319 – 1813 ISSN (p): 2319 – 1805

Tracing the Origins of the Wind Catcher: A Comparative Study of Iran, Egypt, and its Influence on Kuwaiti Architecture

Meshari Almekaimi, Jassim Alobaidan
Civil Engineering department, The Public Authority for Applied Education and Training

--*ABSTRACT*--
This paper explores the architectural significance and evolution of wind towers and wind catchers, examining their various types and tracing their origins across ancient civilizations. Special emphasis is placed on the dispute between Iran and Egypt regarding the invention of the wind catcher. Furthermore, the study delves into how these architectural elements were introduced to Kuwait and adapted to suit the region's hot arid climate. By analyzing historical records and architectural adaptations, the research aims to provide insights into the cultural and environmental factors that contributed to the development and diffusion of this sustainable cooling technology in the Gulf region.
Keywords - *Cooling, ventilation, , Kuwait, Architecture, Wind Catcher*

Date of Submission: 15-09-2024 Date of acceptance: 30-09-2024

3.3 Kuwait in the past: Before 1950

For hundreds of years the inhabitants of the desert have been building up a collection of knowledge and ways of dealing with the same environmental factors that prevail today. This knowledge and the principles of design inherent in the vernacular buildings should not be ignored and abandoned for imported and unrelated designs, (most of desert zone design principles are imported from non-desert regions).

"All this knowledge should be a contributing factor to the design of new settlements in contemporary desert environments. I am not advocating a return to tradition forms or ways of building without using advanced technology; I am simply promoting the combination of traditional knowledge and advanced technology for introducing new design in the desert" (Gabriel,1991).

Mahgoub (2004) demonstrate that there were various styles of vernacular houses in the area. The Bedouins traditional tent was shelter and home during the winter time. It was transported by camels. During the summer time they used to live in shelters called Al Arish which were made of palm leaves. They considered Al Arish the second home (Fig 3.3). the houses were made of coral stones or the Guss (mud mixture made as blocks) covered using palm trunks. Winter houses were located near the cost, while summer houses were mostly near palm tree farms. only some monuments have been preserved in Kuwait as modernization continues to take its toll on the historical buildings.

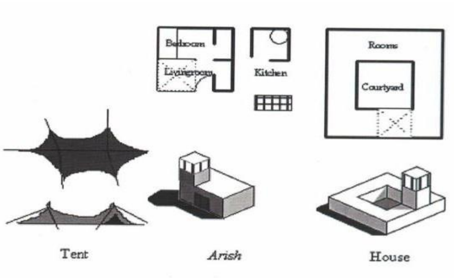

Fig 3.3 Vernacular Dwelling

Mahgoub (2004) reported that a few mosques and diwanias (social meeting houses) have been saved from demolition (Fig 3.4, 3.3), and many have been replaced with new buildings, reflecting the fast transformations in the recent history of kuwait.

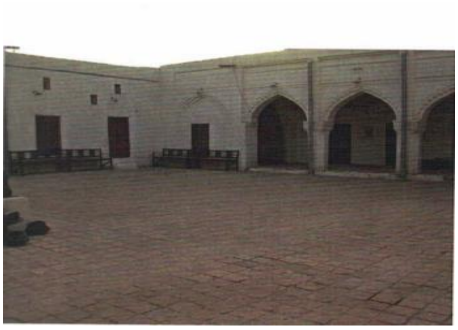

Fig 3.4 Kuwaiti House

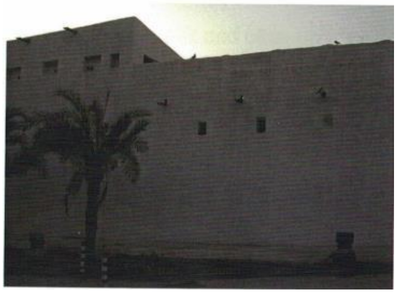

Fig 3.5 Old Narrow Windows

3.4 Building Material

Lewcock (1978) concluded that most of the country is sandy desert bordering the sea. The soil is generally fine wind-blown sand lie on top hard sand or lime stone. On the seaside there is a low lime stone ridge, partly lime stone, partly shell lime stone. In the sea is a grit stone, exposed in many places and in others covered by several meters of sand or salt. In a few areas inland there are low escarpments in which calcareous grit stone is exposed, and occasionally oolites. These stones is not good for building, and unless covered with plaster will quickly weather.

Lewcock (1978) reported that there are some plains into which pebbles of volcanic origin have been moved by sheet flooding. These make good stones and aggregate for the foundation.

With the exception of a few date palm trunks, occasionally available nearby, timber must be imported. Other palm trunks had to be brought from nearby Basra, teak and other good hardwoods from India and Africa, and mangrove poles from Africa. In spite of the need to transport it, wood was a relatively cheap material. Its use was somewhat inhibited by the difficulty of keeping it insects free. Some obstacles appeared with warping, due to its utilization before reaching optimum humidity content. The working with timber was a large business in country.

Lewcock (1978) shown that the glass originly imported from the Mediterranean, Europe, Iraq or Iran, and was rarely used in windows.

foundations were executed in trenches using volcanic pebble stones, which were essential to protect the walls from the water which tends to lie following the rains due to the generally flat topography. Yellow clay tiles were imported from Iraq, and more particularly from Iran. They were mainly used in flooring and for the arches and vaults; the walls were universally of earth bricks or layered earth. Cracking might occur due to the thermal movement induced by the intense solar radiation. This was particularly bad where the roof, which absorbed most of the radiation, joined the walls, and on the east and south ends.

Behling (2000) stated that the builders have resorted to heavyweight solutions. In their quest to cool down in the building. "Those permanent structures found in the desert are made with heavy walls of earth material and walls and roofs are of a double thickness for maximum heat absorption. As rainfall is minimal, waterproofing is not an issue. If heavy desert rains hit the building, most parts of it are easily destroyed and have to be rebuilt".

3.5 Cooling Strategies in the Past

Wind-towers and Wind Catchers

In the densely built-up Gulf towns, with streets purposely made narrow to ensure shade in the heat of the day, any natural movement of the air was obstructed. Cooling breezes tended to be deflected upwards so that they passed over the rooftops without distributing the air below, unless special devices were introduced to deflect the air movement downwards. A wide variety of wind-towers and wind-catchers were employed in the

Gulf, and examples of most of these still survive in old Kuwaiti buildings. However, the use of wind-catchers was not as fundamental to the architecture of Kuwait as it was in some other Gulf and Iranian towns, or even in Baghdad; the site of Kuwait had been chosen because of its relatively mild summers, and, except for brief periods, the humidity and radiation level in Kuwait were not as bad as those in many other places.

The types of ventilators used in Kuwait are separated below into distinct categories (Fig 3.6) according to their method of function. There are two different kinds of ventilator, those which face into the prevailing wind, and those which face away from it and exhaust stale air with the smoke. The second type can also be used for creating an outward draught along the back walls of rooms, to draw air in from a courtyard, thus aiding the natural ventilating action of the prevailing wind. In certain circumstances, where the prevailing winds blow in opposite directions morning and night, or where the direction of the wind reverses itself at different times of the year, exhaust vents, which operate by creating zones of low air pressure, may be converted into wind-catchers with a high air pressure at the vent, thus reversing the flow of air in the ventilator. At the same time the reverse action takes place, the original wind-catchers becoming air exhaust vents. When there is no wind, the hot outside air at the top of the ventilation shafts of both wind-catchers and exhaust vents is cooled when it comes into contact with the shaded walls of the shaft; since the cooler air is denser than hot air, it sinks through the tower causing a down draught of coot air into the rooms. Unwanted air movement in winter can be controlled, in many cases, by doors or shutters at the bottom of the air shafts (Lewcock, 1978).

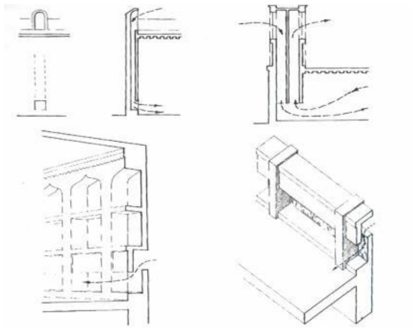

Fig 3.6 Wind-Towers and Wind Catchers

3.5.1 Single Wind-Catchers

Facing the Prevailing Breeze

These were frequently built on the outside walls, particularly on the northern and north-western side, and occasionally on the south-eastern sides. Their shafts usually extended down to an opening less than a meter above the floor, and were commonly built within the thickness of the wall, the shaft measuring as little as 50cm. x 20cm (Fig 3.7). The opening at the top of the ventilator, the wind-catcher, was often very large, a wide recess with a top covering which might be sloping, rectangular or arch-headed, with either a semi-circular arch fronting a shallow barrel vault, or a more elaborate decorative scalloped arch, sometimes of ogee shape.

It was quite common for the lower opening of the ventilator to be incorporated at the top or even the bottom of one of the recesses for shelving in the main rooms of the houses (Lewcock, 1978).

Fig 3.7 Single Wind-Catchers

3.5.2 Wind Towers

The most characteristic wind-tower had a square turret projecting from the top of the house, with open decorated arcades or grilles on all four sides. Internally, the turret is normally divided into four vertical shafts. This may be done in two ways. In northern and western Persia, Iraq and Kuwait (Fig 3.8), it seems normally to have been done by creating four rectangular shafts with cross walls built parallel to the outer walls of the wind-tower; the two vertical shafts facing the directions of the prevailing winds are often larger in cross-section than those facing in the directions at right angles.

Alternatively, the turret is divided into four individual shafts of equal size by two diagonal cross walls. The shafts are carried down through the height of the building to the ceiling of the main reception room, so that cool breezes are admitted from the windward shaft at the same time as stale hot air is drawn out through the leeward shaft, Even more effective is the device of projecting the wind shaft down into the room, so that their openings are no more than 1-1.5m. Above the floor; this is usually done against the back wall or in a corner. While the turret using diagonal cross walls is common in the central and southern Gulf, a number of examples of it may also be seen in Kuwait, notably on the big houses built by Sheikh Khazal al-Khan (Lewcock, 1978).

Behling (2000) indicated that the Wind-towers are at their most effective when built into walls transverse to the prevailing wind, with wide openings. Once the air is taken in, it sinks as it takes on moisture and cools in the channel. This is an example of an air conditioning system at its truest, most sophisticated and most energy-efficient form. All these principles need strong temperature variations to function properly.

Fig 3.8 Wind-Tower

3.5.3 Mid-Wall Wind-Catchers

Universally used in Bahrain, and to a lesser extent in Kuwait, this type of wind-catcher relies on the pressure of wind against the large expanse of the wall of a roof room. A row of such wind-catchers is seen externally as a row of horizontal recesses midway up the height of the external wall (Fig 3.9). At the bottom of each recess there is a shuttered opening which can be closed or opened from the inside. The high air pressure on the windward side of the wall is thus captured and allowed to enter the room less than one meter above the floor, where it creates air movement across the bodies of people sitting inside the room. Internally, there are a series of recessed niches each corresponding to one of the ventilator openings. Using this ingenious device the whole interior of a roof room can be provided with a constant flow of air moving across it at breast level to cool the inhabitants in humid weather, provided that there is a slight breeze blowing outside (Lewcock, 1978).

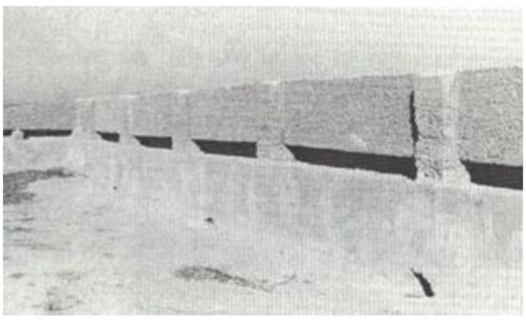

Fig 3.9 Mid-Wall Wind-Catcher

3.5.4 Wind Catchers Parapets

A variation of the above was the wind-catcher parapet, which seems to have been a relatively late introduction into Kuwait, presumably imported from Bahrain, where it is common.

The parapet is constructed of two front planes which are staggered vertically. The outer plane is built of brick or rammed earth and forms the lower half of the parapet. The upper half is recessed behind an air gap and, therefore, has either to be supported on wooden beams, the traditional construction, or manufactured from reinforced material as a slab spanning the upright supports. A horizontal coping should complete the construction, although this is missing in some of the Kuwaiti constructions. This parapet functions in exactly the same way as the mid-wall wind-catcher. The pressure of air in the recess diverts the wind down over the people sleeping on the open roof. In this case, however, there are no shutters closing the air space, as these are not judged necessary and would be an extra expense. It will be noticed that this parapet provides more privacy than the traditional open-screened parapet, while at the same time ensuring that the maximum air movement is obtained close to the surface of the roof (Lewcock, 1978).

Behling (2000) stated that with wide variations in temperature and comfort within a building during the day, its occupants may live on different levels at different times of the day or year. In summertime, occupants may sleep on the roof where it is coolest, while in the afternoons they will seek refuge from the heat of the day by moving into the lowest levels. In September, a family might move to the winter quarters at the south-facing side of the house, while in April the north facing rooms will provide greatest comfort. The occupants use buildings like this in a manner similar to the way the albatross uses the winds.

Behling (2000) also shows that courtyards and loggias are multi-functional spaces. They are not only highly efficient for air conditioning and for comfort generation but also form the main communication link through the house. Japanese pavilions and the Renaissance loggias provide interesting parallels from the realm of spectacular architecture.

3.6 Ventilation

3.6.1 Exhaust Ventilators Facing Away From the Prevailing Wind

Where important rooms faced north across a courtyard, in order to avoid the heating effect of the sun on the courtyard wall during the day it was necessary to draw air into the room on the courtyard side by creating a reverse movement of air from the room up the ventilator, using the suction effect of the wind passing on either side of the projecting ventilator on the roof. This type of ventilator was almost certainly that used in neo-Babylonian palaces, where the reception halls always faced north in the direction of the prevailing wind, and where vertical ventilation shafts have been found in the rear, south walls of these rooms. This custom is widely followed to this day in Zubayr, and until recent times in Kuwait (Lewcock, 1978).

3.6.2 Multiple Ventilators

In heavily built-up conditions it was common to find in Baghdad and Zubayr the grouping of a number of ventilator flues together in a single multiple ventilator from which a number of rooms could be served with cooler air. No examples of this device are known to survive in Kuwait today, although as Zubayr closely parallels Kuwait, it is quite possible that they once existed there.

It has been shown that the people in Kuwait's past used to survive without the need of air-conditioning and chillers. They created and developed reasonable solutions to suit their living conditions and climate. In the previous section we demonstrated the cooling strategies of the past and illustrated that there were a limited number of strategies for cooling in most of the buildings, and there were a response to the Kuwait climate and culture. In the next section of this chapter we will demonstrate how old techniques have been adopted in Kuwait's new buildings.

Iran's Claim to the Wind Catcher

The earliest documented use of wind catchers can be traced back to ancient Persia. Archaeological evidence from the city of Yazd, in particular, suggests that wind catchers were central to Persian domestic architecture as early as the 5th century BCE. Persian wind catchers were sophisticated systems, often integrated with subterranean water canals (qanats) to maximize cooling effects. These systems were not only functional but also reflected the Persian understanding of environmental harmony.

Examples of literature:

Beazley (1979). Iranian Architecture: A History of Form and Meaning. This book discusses the architectural innovation of wind catchers in ancient Persia.

Zargar (2009). "The Persian Wind Catcher: History and Techniques". This article traces the technological development of wind catchers in Iran.

Egypt's Claim to the Wind Catcher

On the other hand, Egypt claims that wind catchers originated within its ancient civilization. Egyptians had developed similar passive ventilation systems that could capture cool air and circulate it in desert dwellings. The structures are believed to date back to the Pharaonic period, around the 2nd millennium BCE. Egypt argues that these early architectural solutions predate the Persian wind catcher.

Examples of literature:
Fathy (1986). Natural Energy and Vernacular Architecture: Principles and Examples with Reference to Hot Arid Climates. Hassan Fathy explores the ancient Egyptian methods of ventilation, including early forms of wind catchers.
Habashi (2004). "The Ancient Egyptian Wind Catcher and Its Evolution". This article delves into the historical roots of passive cooling in Egypt.

3.8 Conclusion

Studying wind towers and wind catchers closely proves that they have a profound impact on architectural cooling techniques across various regions that have hot arid climates. The roots of these structures which stretch to Egypt, Iran, or ancient civilizations reveal the creativity of early societies in finding ways to harness natural ventilation. Although their origin is disputable, the role of wind catchers in sustainable architecture is undeniable. Kuwait's adoption of wind catchers emphasizes the region's historical openness to environmentally-friendly and sustainable innovations. As Kuwait integrated these systems, it embraced an efficient cooling technique while preserving a vital architectural tradition. This study highlights the need to view such innovations in their regional adaptation context, and offers a foundation for future architectural design that incorporates such passive cooling innovations into modern construction.

References

[1] P Gabriel, Housing design in desert regions, *The design & planning of housing*, 1991.
[2] Y Mahgoub, Architecture in Kuwait: A visual account, 2004.
[3] R Lewcock, Traditional Architecture in Kuwait and the Northem Gulf, Flexiprient Ltd, Worthing, Sussex, 1978, p. 11 -40.
[4] S Behling, Solar Power: The Evolution of Sustainable Architecture, *Prestel*, Munich, London, New York, 2000.
[5] Beazley, Iranian Architecture: A History of Form and Meaning, 1979.
[6] Zargar, The Persian Wind Catcher: History and Techniques, 2009.
[7] H Fathy, Natural Energy and Vernacular Architecture, *The University of Chicago Press*, Chicago and London, 1986, p. 4 – 45.
[8] Habashi. The Ancient Egyptian Wind Catcher and Its Evolution, 2004.