Windcatcher

A **windtower (wind catcher)** (Persian: بادگیر *bâdgir*: *bâd* "wind" + *gir* "catcher") is a traditional Persian architectural element to create natural ventilation in buildings.[1] Windcatchers come in various designs: uni-directional, bi-directional, and multi-directional. The devices were used in ancient Egyptian architecture. Windcatchers remain present in Iran and can also be found in traditional Persian-influenced architecture throughout the Middle East, including in the Arab states of the Persian Gulf (mostly Bahrain and the United Arab Emirates[2]), Pakistan, and Afghanistan.[3]

An ab anbar (water reservoir) with double domes and windcatchers (openings near the top of the towers) in the central desert city of Yazd, Iran

Contents

Background

Central Iran shows large diurnal temperature variation with an arid climate. Most buildings are constructed from thick ceramic with high insulation values. Towns centered on desert oases tend to be packed very closely together with high walls and ceilings, maximizing shade at ground level. The heat of direct sunlight is minimized with small windows that face away from the sun.[3]

The windcatcher's effectiveness had led to its routine use as a refrigerating device in Persian architecture. Many

traditional water reservoirs (*ab anbars*) are built with windcatchers that are capable of storing water at near freezing temperatures during summer months. The evaporative cooling effect is strongest in the driest climates, such as on the Iranian plateau, leading to the ubiquitous use of windcatchers in drier areas such as Yazd, Kerman, Kashan, Sirjan, Nain, and Bam.

A small windcatcher is called a *shish-khan* in traditional Persian architecture. Shish-khans can still be seen on top of ab anbars in Qazvin and other northern cities in Iran. These seem to function more as ventilators than as the temperature regulators seen in the central deserts of Iran.

Windcatchers in Egypt

Windcatchers were used in traditional ancient Egyptian architecture. A painting depicting such a device has been found at the Pharaonic house of Neb-Ammun, Egypt, which dates from the 19th Dynasty, c. 1300 BC (British Museum).[4] In Egypt the windcatchers are known as *malqaf* pl. *malaaqef*.[5][6][7][8]

Dwelling house in Ancient Egypt with windcatcher.

Structure and architecture

Windcatchers tend to have one, four, or eight openings. In the city of Yazd, all windcatchers are four- or eight-sided. The construction of a windcatcher depends on the direction of airflow at that specific location: if the wind tends to blow from only one side, it is built with only one downwind opening. This is the style most commonly seen in Meybod, 50 kilometers from Yazd: the windcatchers are short and have a single opening.

Ancient Egyptian House miniature showing windcatchers, dating from Early Dynastic Period of Egypt, found in Abou Rawsh near Cairo. Now in Louvre.

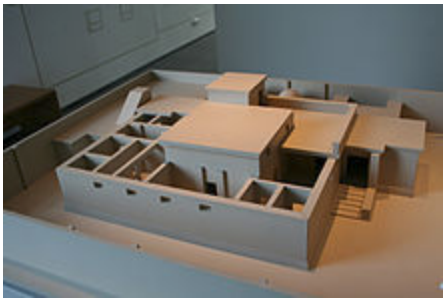
Function

The windcatcher can function in three ways: directing airflow downward using direct wind entry, directing airflow upwards using a wind-assisted temperature gradient, or directing airflow upwards using a solar-assisted temperature gradient.

Downward airflow due to direct wind entry

One of the most common uses of the windcatcher is to cool the inside of the dwelling; it is often used in combination with courtyards and domes as an overall ventilation and heat-management strategy. It is essentially a tall, capped tower with one face open at the top. This open side faces the prevailing wind, thus "catching" it, and brings it down the tower into the heart of the building to maintain air flow, thus cooling the building interior. It does not necessarily cool the air itself, but rather relies on the rate of airflow to provide a cooling effect.

Windcatchers have been employed in this manner for thousands of years.[9]

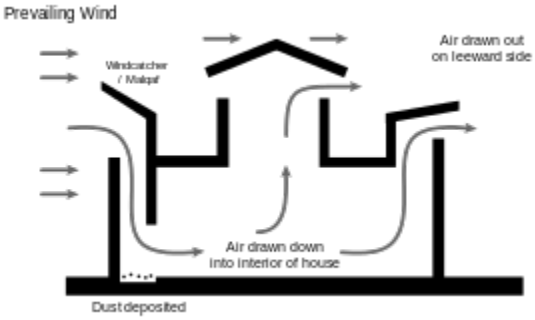


Model of an Ancient Egyptian house with windcatcher, Roemer- und Pelizaeus-Museum Hildesheim

Upward airflow due to temperature gradient

Wind-assisted temperature gradient

Windcatchers are also used in combination with a qanat, or underground canal. In this method, the open side of the tower faces away from the direction of the prevailing wind (the tower's orientation can be adjusted by directional ports at the top). By keeping only this tower open, air is drawn upwards using the Coandă effect.



A windcatcher or *malqaf* used in traditional Persian/Arabic architecture

The pressure differential on one side of the building causes air to be drawn down into the passage on the other side. The hot air is brought down into the qanat tunnel and is cooled by coming into contact with the cool earth[Note 1] and cold water running through the qanat. The cooled air is drawn up through the windcatcher, again by the Coandă effect. On the whole, the cool air flows through the building, decreasing the structure's overall temperature. The effect is magnified by the evaporative cooling of water vapor when the air passes through the qanat water canal, as the water that evaporates in the canal has a large enthalpy of vaporization and, besides, the dry air is humidified by the evaporated water from the canal before entering the building.

Solar-produced temperature gradient

In a windless environment or waterless house, a windcatcher functions as a solar chimney It creates a pressure gradient which allows hot air, which is less dense, to travel upwards and escape out the top. This is also compounded significantly by the diurnal cycle, trapping cool air below. The temperature in such an environment cannot drop below the nightly low temperature.

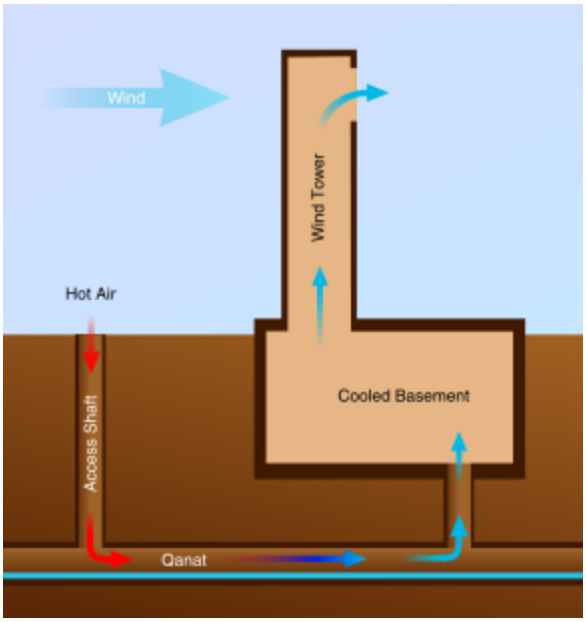
When coupled with thick adobe that exhibits good resistance against heat transmission, the windcatcher is able to chill lower-level spaces in mosques and houses (e.g. shabestans) in the middle of the day to frigid temperatures.

Directing airflow upwards using wind-assisted or solar-produced temperature gradients has gained some ground in Western architecture, and there are several commercial products using the name *windcatcher*.

Modern applications

The windcatcher approach has recently been utilized in Western architecture, such as in the visitor center at Zion National Park, Utah,[10] where it functions without the addition of mechanical devices in order to regulate temperature.[11]

Using aluminum for the windcatcher provides a more efficient capturing system, allowing for wind capture from multiple directions. The Kensington Oval cricket ground in Barbados and the Saint-Étienne Métropole's Zénith both use this method.[11]



A windcatcher and qanat used for cooling

Gallery


The windcatcher of Dolat Abad in Yazd, Iran — one of the tallest existing windcatchers


Borujerdi House, in Kashan, central Iran. Built in 1857, it is an excellent example of ancient Persian desert architecture. The two tall windcatchers cool the *andaruni* (courtyard) of the house.

The tower on this barasti (palm fronds)-made house catches the wind the same way as a normal wind tower and cools the interior.

Windcatcher of Ganjali Khan Complex, in Kerman, Iran

Golestan Palace, Tehran, Iran

Example in Souq Waqif, Doha, Qatar

See also

- Qanat
- Solar chimney
- Solar updraft tower
- Yakhchal

Notes

1. The earth stays cool by virtue of being several meters below the surface

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