

Natural cooling systems in sustainable traditional architecture of Iran

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ABSTRACT

This paper concentrates on the results of sustainability caused by natural cooling systems in Iranian traditional architecture of hot-arid regions.

Sustainability in architecture means conserving constructions for the future, in terms of physical durability planet protect conserving on energy resources. In this case, it seems that sustainability would be based on the introduction productive models in which available materials and resources are used more efficiently, rather than being ignored. Nowadays, the knowledge of building ecology focuses on its capacity to integrate environmental and climatic parameters into design and thus enhances space qualities such as comfort ability. Traditional architecture of Iran is perceived sustainable for having sustainable features. It is able to response to environmental problems from a long period. Its features are based on climatic factors as well as local construction materials of hot-arid regions and natural cooling systems are one of these feature.

There are various natural cooling systems in traditional architecture of Iran Like: Showdan, Khishkhan, Shabestan, Hozkhaneh and Badgir or windcatcher.

Wind tower is an architectural element in traditional architecture of Iran.

That is seen in hot climates, hot & dry and hot humid. It makes available auditable natural ventilation which is known as an important principle for conserving energy. Traditional building techniques are normally well adapted to the climate and we can use them with new technology.

This paper concludes that according to some

factors it is possible to address Iranian traditional architecture. Iranian traditional architecture delicates effect of climatic forces on forming of habitable spaces and it explains climate was seen like environmental- constructional subject. It is undeniable importance use of sustainable and renewable source of energy such as wind structure and form of building. Result of this approach is harmony with nature.

The aim of this research is to demonstrate the rule of natural cooling systems in sustainability of traditional architecture in hot-arid climate of Iran.

1. INTRODUCTION

"Evaluation of traditional solution in local architecture precedes the development of those that are mechanical in order to accept these methodologies or remedy them to corn from to modern sophisticated requirements... This process should be based on new progresses acquired in humanities, physics as well as in sciences such as material technology, physics, aerodynamics, meteorology and physiology" (*Hassan Fathi, an Egyptian architect*).

This paper focuses on the results of sustainability caused by natural cooling systems such as Showadan, Khishkhan, hozkhaneh, Sabat ,wind catcher (Bad – gir) as a climatic elements in Iranian traditional of hot regions. It is perceived sustainable for having sustainable features and able to response to environmental problems from a long period. Its features are based on climatic factors as well as local construction materials of hot regions. Wind catcher as one of the determining and organizing factor of traditional architecture in Hot – Arid regions

involves various aspects. Then, we will investigate these elements as sustainable elements traditional architecture of Iran.

2. CLIMATE OF IRAN

There are different geographical locations in Iran and this provides various climates and every climate has its special characteristics, Iranian researchers like M. Tavasoli, M. Kasmaee, and Dr. H. Ganjee worked on climatic divisions of Iran but the method of Dr. H. Ganjee is the best. He divided Iran based on Koppen's method. Koppen divided the world based on growing of plants. Microclimates have effected on urban planning and architecture. In a vast country such as Iran. With different climatic zones, traditional builders in the past have presented a series of logical solutions for human comfort. Iran is basically divided into four climatic regions: Mild – Humid Climate, Cold Climate. Hot – Mild Climate, Hot – Arid Climate. Here, we just describe natural cooling systems like: Showadan- Sabat-Khishkhan and Badgir (wind catchers).

2.1 Hot-arid Climate

This Climate consist of the most parts of the central Iranian plateau , receives almost no rain for at least six month of the year, hence it is very dry and hot. In this climate the summer is very hot – arid and the winter is very cold and hard. In this area, sky in the most of months of year is without cloud and the weather hasn't nay humidity. Thus temperature is very variety in the past has presented a series of logical solutions for human comfort. A principle for the existence of building is the need for better environmental conditions. "Early men built houses to keep out the elements – rain, wind, sun and snow. Their purpose was to produce an environment favorable to their comfort and even to their survival" (Fathy, 1986).

This attribute draw a connection between the architecture and the climate and demonstrates a physical and architectural characteristic in a particular region.

2.2 Hot-humid Climate

This region lies along a narrow and relatively lengthy littoral strip of me Persian Gulf coast the length of which exceeds more than two

thousand (2000) kilometers. In terms of climate, the different zones of this strip are considered as hose with hot and humid climates. They have rather long summers and winters with short days. In fact, there is normally rather cold weather only during two mouths, Jan. and Feb. (as under the rubrics of train months): in this area, there are very high levels of evaporation and air humidity because of its approximate to the sea and vertical solar radiation in both spring and summer on the one hand and because of the existence of typical soil of this area which is physically calicoes and because of very hot weather, the grass and plant covering is very meager on the other hand. Too much humidity of air across the sea coast and much. Heat of air in hot seasons create a sweltering weather that develops a very troublesome living condition.

3. NATURAL COOLING SYSTEMS IN IRANIAN TRADITIONAL ARCHITECTURE

By me age of industry, people living in hot regions only relied on the natural source of energy to ventilate and cool their houses. System and equipment by which wind is used for ventilation were, therefore, considered as ways and means of providing comfort and easy life in buildings.

Elements such as badgir or wind catcher khishkhan, and central court yard or spaces such as hozkhaneh or shabastan in vernacular architectural planning as well as elements such as Sabat, ice builders and water reservoir where very popular in Iranian old cities planning. These space and elements produced cooling and ventilation in urban and architectural spaces and also provided comfort. If it is supposed here to return dealing with metrologies and solutions to use natural energy and dispense with or avoid using unconditionally and unlimitedly the mechanical ventilations that were commonly applied in late years of 20 th coutury so that we may save irretrievable and irrecoverable fuel supplies and protect our environment, it would be necessary to conduct proper studies on traditional systems. For this reason, we will study and analyze vernacular cooling systems.

3.1 Wind Catcher (Badgir)

Wind Catcher as a name implies are ventilation techniques for natural cooling. They have been need for centuries in several countries of hot –

arid and hot-humid climates, particularly in the Middle East countries. Typical wind catchers consist of a tower and a head projecting above the roof of the building. Wind Catcher as a name implies are ventilation techniques natural cooling. They have been used for centuries in several countries of hot – arid climates, particularly in the Middle East countries. A typical wind catcher consists of a tower and a head projecting above the roof of the building.

The tower head many have vents on only one side facing the predominant wind direction.

However, two or four sides of the tower might be open to accommodate wind in all directions. The tower would be subdivided, respectively, into two or more groups of shafts. This subdivision allows air to move separately up and down the tower at the same time and provides more surface area in contact with the air. Consequently, the roof – top breeze is drawn and is diverted to the summer living zone indoors drawn and is diverted and, vice versa, the incoming air would be cooled by the mass of this structure and effect the microclimate indoors in regions in hot and humid climates in south of Iran, the air temperature rises to 25 centigrade in summer from time to time and heat mixed with humidity provide a very adverse condition.

3.2 Showadan

In regions in hot and humid climate in south of Iran, the air temperature rises to 20c in summer from time to time and heat mixed with humidity provide a very adverse condition. Coping with these natural hardships, people of the regions, however, innovated interesting courses of action in their architectural planning and urban planning. One worthy- of- note expediency is the use of a space called showadan. This version of space development consists of a room or rooms that are built 6- 7 meters lower than ground surface and ground floor. These rooms have rather the same temperature in all seasons of year and exceed 25 c to gain access to showadan, sets of stairs are provided extending from veranda (Ivan), alcove and room down to court yard. Showadan also has adequately vertical ducts to produce sufficient light and the illuminating part of duct is laid on the surface of courtyard.

These ducts are called Sisara in Shushtar city and Dozbarreh in Dezfulcity. In some

showadans a vent hole (roof window, canal) is used for ventilation. Sometimes fabricated canals connect the showadans of neighbouring houses, in particular houses the family members of which were relative to those in other houses. Showadans were also used as shelters during wartime.

3.3 Cellar-Shabestan

In all Iranian vernacular houses shabestan is considered to be the same basement which was earlier most popular and prevalent. A shabestan now covered the entire surface below ground floor of the building and then covered only one part of it. It has a ceiling about one meter higher than the surface of courtyard and the rest was designed to position underground. For example, in Tabas city, the summer living part of houses is designed to face the wind below with no sunshine. Single faced louver and against- the- wind veranda- in particular against favorable wind- are main specifications of the houses built in this city one sample of it shows that the intermediate series of louvers are as curtained for rooms and the two louvers on both sides for cellar (basement).

The cellar with its small illuminator under veranda takes a dim light. The two louvers (vent holes) conduct cool air blowing from the North into the cellar and produces good ventilation and cooling here in very hot summers. What covers the courtyard as grass or plant covering are nothing but palm shrubs which produce with a pond in the middle of central courtyard a typical micro- climate with increased humidity and decreased temperature.

3.4 Sabat

One noticeable and conspicuous of urban planning in old location in cities with hot- dried climates is the roofed lane and porches passage. It is called sabat. A sabat is designed in order keep safe human living in desert from direct radiation of sunlight in shade for some moments. In fact, Iranian architects, in some instances, built houses up to somewhere lying on the lane and began to build one or more protruded rooms with same eaves above the passage all commuting was made under these rooms called sabats. A sabat can modulate a transient temperature. It is such a way that any pedestrian on his way to his destination is positioned in shade in a suit-

able succession. In many sabats, there are several integrated entrances of houses that are of highest importance in view of improved sense of neighbored and local correlation. A sabat can be also used as a mean of countering monsoons. The roofs of sabats, are usually by neighboring unites same of which are in the forms of roof commanding the lane underneath. Debate is more usually laid up from blind alleys. A string gate is also more usually fixed at its entrance. Such space is commonly called "darband" that is in sum, wholly suitable to provide added security for the occupants across the lane.

3.5 *Khishkhan*

One more cooling system that existed in hot-arid climate is Khish or Khieshkhan that has been used in Iran from time memorial. It was look a hut or "Dar Aferin" that was encircled up with mats, tiles or thistles and splashed with water now and then so that cool air is conducted in to the room with the wind blow. This space-Khishkhan - was more often used out of doors hot summer.

3.6 *Courtyard (Hayat-eMarkazi)*

The courtyard (Hayat- e – Markazi) in a hot dry and hot humid climates are usually the heart of the dwelling spatially, socially, and environmentally. Although, the size of the land, to some extent, is influential, the average sizes of the courtyards are generally determined according to the latitude. They are narrow enough to maintain a shaded area during the heat of the day in summer, but wide enough to receive solar radiation in winter. A courtyard can provide security, privacy, and a comfortable place within the house. The courtyard where it is usually planted with trees, flowers and shrubs, not only provides comfortable condition and beautiful setting, but also supplies some shade and increase the relative humidity of the courtyard space. "Even without modern, mechanical heating or cooling systems, the courtyard house provides a comfortable living environment through seasonal usage of sections of the structure. The thermal performance of courtyards have been studied by many researchers (Roaf, 1982; Bonine, 1980; Givoni, 1976).

An appropriate explanation however, can be provided by considering the thermal properties of the air and the material of the courtyard .As

the thermal capacity of air is very low, the temperature of the courtyard air follows very closely the temperature of the surrounding surface at night, the mass of the walls and floor of the courtyard is cooled by outgoing long wave radiation, and therefore, the surface of the courtyard floor and walls will remain cool by the following morning. In this way, the mass of the walls and floor of the courtyard (and not the air deposited in the courtyard) serves as a reservoir of coolness, if it is not too large and well shaded. For this reason one may feel cool in two ways, firstly, the courtyard air is cooled in contact with the surrounding surfaces, and secondly, by losing heat through the surrounding surfaces by radiation which is known as radiant cooling.

3.7 *Air vent of dome roof*

Wind towers can be employed in conjunction with curved roofs, which are another type of traditional convective cooling systems. The hot air that gathers under a curved roof is well above the living area of the room. In this way the room is kept more comfortable and heat transfer from the roof to the room is limited because a light temperature is maintained next to the roof. A curved roof is most effective when it incorporates an air vent. The operation of an air vent depends on the fact that when air flows over a cylindrical or spherical object, the velocity at the apex decreases. If there is a hole at the apex of a domed or cylindrical roof, the different in pressure includes the hot air under the roof to flow out through the vent.

An air vent is usually protected by small cap in which there are openings that direct the wind across the vent. Since the functioning of the vent depends on air flowing over a curved surface, roofs with vents are oriented to present the maximum curve to the wind. In areas where the wind is a prevailing one cylindrical roof are built with the axis of the cylinder perpendicular to the wind direction, in areas where the winds blow in all directions domed roofs are employed. Air vents are usually placed over the living rooms of buildings.

4. CONCLUSION

Many traditional societies in climate with hot seasons were thermally adapted and often lived

comfortably for centuries. The solutions substantially relied upon creative architectural structures that were developed to make use of natural energy. “They were able to do so because they made use of the energy available locally in the environment”. (Walter Shearer, quoted in Fathy, 1986; P. XV)

A structure of compact clusters of courtyard houses in form of dense mass of cells, common walls, and alleyways were developed to reduce the total exposure surface area to direct solar radiation received by each house. In such structure provision of windows on external walls was not feasible, and elements like: Showdan, Khishkhan, Shabestan, Hozkhaneh and wind catcher were the best key to facilitate natural ventilation. This function, in fact, necessary for the courtyard houses where there is little opportunity for cross ventilation. Traditional architecture in hot – arid and hot-humid climate of Iran, rely on renewable fuels, It use from solar energy for heating in the winter. Wind energy for cross ventilation and cooling in the summer.

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