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Recognition of sustainability in Iran's vernacular architecture

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Abstract

The subject of supplying thermal energy, i.e providing comfort inside the building for residents and supplying cold and heat by building is essential to be discussed in architectural term. The majority of dwelling spaces were designed on the basis of corresponding man demands and environmental conditions and gradually created an exceptional combination of art and technology. However, in the architecture related to 20th century, by giving extreme importance to so-called modernism is distinguishable. Of course, the cost for being technological is going to ignore other values. A challenging question, which is always raised when scholars review the methods and characteristics in sustainable architecture, is the claim that Iran's vernacular architecture has complied sustainable principles.

Key words: Vernacular, sustainability, solar energy, thermal energy

Introduction

In the history of architecture and constructions, designers mainly make an attempt to respond to climate changes. In architecture, climatic design represents itself as a priceless solution whether it is village dwellings in Alpe Mountain, faced south to be protected against wind or court yards of traditional houses for being protected from cold weather in hot and arid climate. Examples of climatic design can be found in salt-box houses in Massachusetts (figure 1) or elevated iwan in South-American farmland.

Figure 1: Salt-Box House" built in 1738

Figure 2: A traditional Batak house, Sumatra, Indonesia

Figure 3: A Yurt or ger, a circular dwelling from Mongolia during erection

In these vernacular buildings and local styles, climate and weather are considered as the basis of life and man's activities that eventually are helping architecture improve and can be encouraging for the sense of aesthetics in designing architectural form. Figure 2 and 3 indicate some two examples of climatic houses. Using local materials and building orientation play significant roles in building vernacular architecture.

From living point of view, even in tough climate condition, there are some ways for providing comfort and saving energy consumptions. The important thing to know is perceiving the architectural values in each era and region, knowing how building corresponds with specific climate. As climatic borders are not related to political aspects and the climatic characteristics for people who live in climatic regions are similar to each other, the presented solutions for people in similar climate across the country seem to be different in shape but equal in meaning.

Iran's architecture by the influence of environmental characteristics can be divided into two groups: introverted architecture that practices in hot and arid climate such as central parts in Iran and desert areas and cold climate as well. The lack of natural green space and proper weather in aforementioned areas ended up to designing court yards in order to provide lighting and view of physical spaces as somewhere for spending leisure time. But, extroverted architecture is common, mainly in suitable climate or tropical areas or mild weather,.

Therefore, the views of physical spaces are provided by open spaces. Discrete and discontinuous texture of spaces can accelerate ventilation. Of course, in hot and arid climate and even sometimes cold, some spaces are designed extroverted in gardens and green spaces in such way that openings are faced gardens. Gardens located in these areas have fences in their surroundings that make them introverted over other spaces. Also, it may be seen that introverted spaces are used in places such as mosque, madrasa or seri. Now, climatic factors including water, weather, sun and land are discussed below.

In some desert areas such as Yazd and Naeen that tab water is provided by qanat (figure 4) or pond, the housing level is set in such a way that in areas that river is flowing some meters lower, water can easily flow in each housing and after supplying dwellers' demands, goes down to gardens. The influence of water in shaping houses is due to their access to water but their destructive impact in building and environment in areas located to Caspian Sea cause that houses are situated on a face that keeps certain distance with land to prevent humidity from penetrating to building.

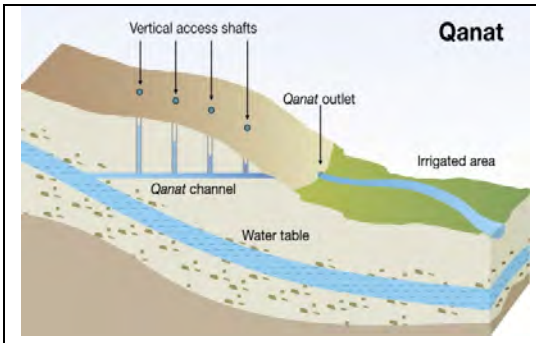

Figure 4: Ganat

Weather

The combination and assembly of housings in compact, contiguous, open or discrete forms and building orientation are influenced by weather. For example, in areas with hard winds or typhoons, building orientation is chosen to protect the residents from probable damages. Even climatic characteristics respected in slums in south of Iran against the unbearable weather in the summer. The interior design help the ventilation by breeze, additionally, the location of hole are designed to benefit from the ventilation the most.

In some areas that it is not possible to benefit from ventilation near the floor level or the texture and locations for windows do not let use the natural ventilation directly, wind tower on top of house help use ventilation. In four-faced house, elevating the central part make the ventilation of interior space possible by letting the natural circulations. It is worth mentioning that in hot and arid climate, many people sleep on roof for having the fresh air. Fences and surroundings in above houses are designed net-like to provide privacy and the possibility of taking advantage of air flow.

Using crypt and basement was a common way to benefit from cool weather. The depth of basement estimated 6-8 meters and the difference temperature with open space was about 20 degree or even more(Kiani, 1989). Basements are not only exclusively seen in residential places but they also are on other architectural spaces such as mosque, Madrasa. It is necessary to know that materials such as adobe, brick and building thick walls and double shells ceiling play an important role in keeping the interior space warm during the winter and cool in the summer,

Although in some cities and rural areas in hot and arid climate depending on land and the existence of favorite wind, Iwans are built toward cooling wind and there are plenty of examples on coastal area in North of Africa and coastal towns in Persian Gulf such as Bandarabbas, it is vital to know as the plans are compact and closed, wind tower can help ventilation. Wind tower is an architectural icon in hot and arid climate. Locating the city on foothills create relatively cool weather or in reverse due to hot and stormy wind, the city may not have the wind tower. A good example of wind tower is in Kashan and Yazd.(figure 5 and 6)

Figure 5: Borujerdi ha House, in 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

Figure 6: The windcatcher of Dowlatabad in Yazd, Iran—one of the tallest existing windcatchers

As the existence of four-sided wind towers in Kashan can be justified by favorite winds coming from Karkas mountains but in other area, locating in north-east of Kashan named Aran, we rarely see wind towers and those which exist, are short. Due to dusty wind, the wind tower does not function properly and in return, replace with suctions that make the crypt much cooler, the opening of crypt is below the Iwan and with one or two suctions are drawn up.

In cities that favorite wind has a determined orientation, a one-faced wind tower is required. A row of this type can be seen in Tabas. The collection of Aghda has the same type because they direction of cooling and stormy winds in cities is different, as a result when stormy wind blows in behind, wind tower functions as a suction and sucks the inside air to outside (Watson, 1983)

Wind mills benefit from stormy wind as well. These mills usually work along each other regularly and sometimes a row of them is one kilometer. In this case, they can protect any complex opposite them from stormy winds.

Sun

Sun has a dual role in shaping the architectural spaces and quality of living. At first, prevention heat, caused by sun radiation in the summer in hot and arid climate and requiring shaded space in corresponded season and paying attention to using heat in the winter and expecting solar spaces bring building orientation and make interior spaces in such a way that they can benefit from the maximum of sun radiation and prevent them from entering the space in the summer.

The thermal exchange between user's body and surrounding is as follows:

- Conduction (direct contact)
- Conduction-air movement
- Evaporation-movement of skin humidity
- Radiation (solar and thermal)

The human body can produce heat that depends on each individual's activities. The rate of thermal energy produced by metabolism plus skin determines the body heat storage.

- Cloth heat resistance and the rate of temperature of surface in contact with body
- Thermal resistance of cloth, weather temperature and circulation speed
- The presence of water pressure in the air
- the surface temperature around body

In order to achieve what mentioned above, in many cities, buildings face south especially south west and even south east that is the most important direction for benefitting from sun in winter. Due to prevent sun radiation from entering the rooms, designers come up with new ideas such as building an iwan in front of the mentioned rooms or installing vertical and horizontal sun-breakers (Figure 7) or sash window (figure 8) and stained glasses can reduce the intensity of sun and finally the simplest solution would be a curtain.

Figure 7: Sun-breaker

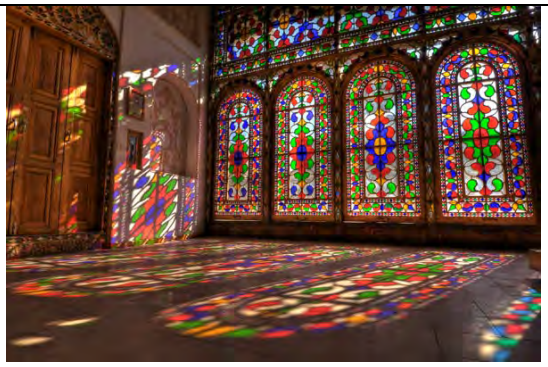

Figure 8: Sash windows

Three-doors (Seh-dari) should be designed to block sun radiation coming inside. Unfortunately, in Qajar dynasty, different architectural elements were applied for the first time. Three-doors (Seh dari) were replaced with two-doors and were built to let sun come to place. Supplying lighting from ceiling is another solution to prevent the direct sun radiation from

penetrating certain places and experienced architects believed in there would be sufficient (and sometimes in extreme) sun and they did not feel to require it in houses rooms.

In old houses whether royal house or small ones, some amount of lighting is supplied from ceiling. Additionally, this type of lighting is accompanied by mild colors of walls and ceiling and creates comfort and calmness. On the other hand, due to blocking west face of house and prevention direct sun radiation, these parts benefited from light in some spaces in back; this simple arrangement was applied to some spaces such as kitchen and pool in garden.

Sun and its heat are essential in arranging and organizing activities and spaces in residential places such as Zemestan-Neshin spaces, which were located in northern face and opposite sun that can use the heat in winter and in southern face of building spaces such as Iwan, hall and Tabestan-Neshin (southern part) , locating back to sun in summer and the air is cooler in comparison parts. It rarely occurs that main space is accommodated in east face but service spaces were built in those parts. But western face, benefitting from east lighting was given to service spaces and rarely main spaces. In hot and arid climate, rural and urban complexes are compact and it can prevent heating produced by sun, penetrate to space. Eaves not only provides privacy, but it also blocks unfavorable wind, and create shade. Closed space and porosity can reduce the direct contact with inside heating.

Light color of adobe can reflect the heat. The domes shape of roofs has a structural justification as the shortage of wood makes them discover a proper solution and build wide opening. In hot and arid climate, it can help solve the heating and reflection during night (Pirnia, 1992). Walls and thick roofs prevent the heat penetration. Adjacent houses can create a mass and shade in court, therefore some cooling space that residential units are filled with it. This spatial regulation stems from biological needs and cold weather sits on deep holes in the yard and for certain times, the court temperature especially the parts back to sun is cool.

Land

In mountain areas, slope is more important than direction and path of sun radiation. Therefore, building orientation is determined according to natural factors and their roles in people's life. The variety of climatic characteristics ends up valuing the different direction.

With respect to the afore-mentioned issues, we can conclude that Iran's vernacular architecture has applied sustainability properly. Below, we discuss two types of public buildings to discover trace of sustainability.

Reservoirs

Considering the relative dryness of Iran's climate, the shortage of rivers and the low level of aquifer, people need to supply water and it leads to building dams, qanats, channels, wells and reservoirs to solve this common problem. Public reservoirs became very important as sometimes it is considered as the most elaborate architectural building. The distributions of reservoirs correspond to climatic conditions.

Hot area and the fringe of desert such as Yazd have the most numbers of reservoirs and north, north-west the least. The common types of reservoirs are mainly in central parts of Iran and their components consist of entrance, stairs and cylinder-shaped storage with wind tower and dome shell. In order to keep the water cool and ventilating the space, most wind tower and air duct were installed in them Figure 9 and 10)

Considering the climate and the direction of wind, wind tower has valves in different sides that favorite wind is pulled in and out from opposite side. This airflow can make the water cold and ventilate inside the tank. Wind towers can create a harmony with buildings for their beautifully architectural entrance.

Figure 9:Reservoir with six wind tower

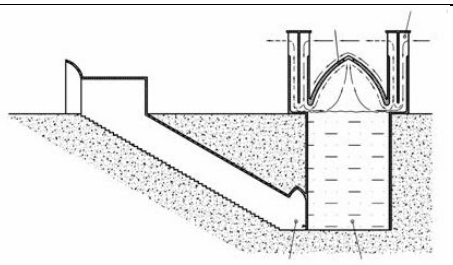

Figure 10: Section of a reservoir (Pirnia)

Wind towers are four, six and eight edges and sometimes reservoirs without wind tower have some air vent that help the air circulation (Tavasoli, pp66, 67).

Hammam (bathroom)

These buildings are considered as public places, due to easy access to water flow, heating the interior space in winter and fortification, almost all of them were designed below the passages. Designing and spatial hierarchy from outside Hammam to heating room could make a thermal balance (Fakhari, p. 171). The Hammam consists of three important parts, first it is to know that bathroom is a closed space but by holes on roof or oil lamps, lighting is provided. When the user is proceeding toward the steam room, the space becomes hotter. The anteroom, when people get undressed is located at first part the by a corridor people can reach *sar(-e) ḥammām, raḵtḵān, jāmaḵāna, or sar-e bīnam. This room is vaulted (figure 11)*

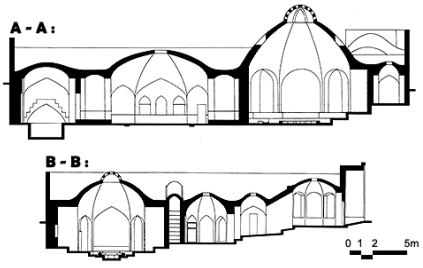

Figure 11: **Golshan Bath section (Pirnia)**

An architectural approach to sustainability

Most old building, as mentioned above are equipped by thick walls of basements and cool crypt in the summer and five-doors or halls, were designed with respect to sun radiation and are built to absorb the maximum of heat in the winter or like wind towers provide cool and mild air flow. These buildings used the minimum thermal energy and without any cooling device could create a comfortable, calm and desirable for residents (Tabrizi, 2002).

Instead of using tick walls (50 centimeter) the usage of thinner ones (10 centimeter) , replacement of wood and brick with metal structure and changing the adobe ceiling with low heat transfer coefficient with tar covering that can absorb heat the most in the summer are improper

techniques for constructions. A big window from ceiling to floor seems as a cage and due to inexpensive energy and the abundance of resources, apparently the society is leading to consumerism.

Nowadays, residential and commercial towers are mainly built with full glass façade and metal structure or armed concrete and it seems that most of them are copied from other each other regardless influential factors such as climate, local material and saving energy. Many of these find problems with cold and heating systems problem. The common justification is to follow main stream and using commercial materials without considering probable problem, caused for present and future (Mofidi, 2003)

An intelligent design can help architect design buildings with respect to form, limited glass surface and proper angle with accordance with climatic condition and along with using an advanced technology for insulation; they replace fossil fuels with renewable sources. Additionally, active and passive solar method, wind, earth thermal energy and producing energy are their priorities.

In general, the solution below can help make a bridge between Iran's vernacular architecture and principles of sustainably:

- Climatic designing
- Using renewable sources of energy
- Combing different methods
- Using proper building equipments
- Applying indigence building system

A building should be designed in order to absorb heat for residents in the winter and prevent waste of energy. The source of energy is sun and architects use a passive system to trap sun energy.

Conclusion

In this method, sun radiation directly produces heat in the building and room is absorbing it, more importantly, no mechanical and installation are applied in other words it has no fee and the building itself receive and keep the energy and only needs the science of climatic designing. Climatic designing is a method for reducing the overall cost of energy in the building. Designing a building would be the first defensive phase against the climatic factors. In all building, the necessity of heating and cold is minimized and in return the existence energy is applied.

Saving for a long time can introduce climatic techniques as the best investment for building owners. Surprisingly, the majorities of them are free and just require the science and knowledge about climatic architecture. Of course, it results in reduction in energy consumption especially in fossil fuel. This type of designing is mostly depending on solar energy. Perceiving climatic designing is not complicated. The users' comfort and peace of mind is achieved by making a balance between thermal energy of us and our surroundings.

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