

The Effect of Environmental Sustainability in the Architecture of Persian Garden's Pavilion

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Abstract

This paper will concentrate on the result of a research based on study on parameters of creating the main built space in Persian garden; pavilion. Traditional architecture of Iran is known as a sustainable architecture and this method of design has responded to environmental constraints for many millennia. Pavilion is the only extrovert residential space among the traditional buildings in arid regions. The formation of Persian garden and its pavilion's been affected from various parameters of design, and considering to environmental and climatic conditions is one them. The selected case studies are four different types of pavilions in the cities of Isfahan, Kashan, Shiraz and Yazd, which are located in different microclimates in arid regions. By the analysis of sustainable and climatic features of Persian gardens 'pavilions in these cities, the main purpose is to identify the parameters of creating ingenious spaces in Persian gardens in arid regions will be obtained.

Key words: Arid Regions, Pavilion, Persian Garden, Sustainable Architecture

1. Introduction

Sustainability could be observed in many aspects and elements of Persian garden .Gardens have been employed to moderate local climate by Iranian architects for many millennia. The lack of green spaces in the vast arid regions in Iran, have led the creation of many different and innovative solutions to heat and dryness. The traditional landscape architecture of Iran has devised many sustainable principles and has responded to the environmental problems for

centuries. Its characteristics are mainly based on climatic and sustainable factors and some other intellectual features (Fadaie, 2009). The main design elements of Persian garden are water, vegetation and the built element; pavilion. Since the explorations of pavilion's characteristics seem unfeasible without an understanding of Persian garden, explanation of Persian garden's concept in this research is unavoidable. The arc type of Persian garden is called Chahar Bagh, which means four gardens and its design is based on rectangular shape, surrounded by four walls and crossed by two water courses which intersect at the right angle which is occupied by pavilion (Figure1).

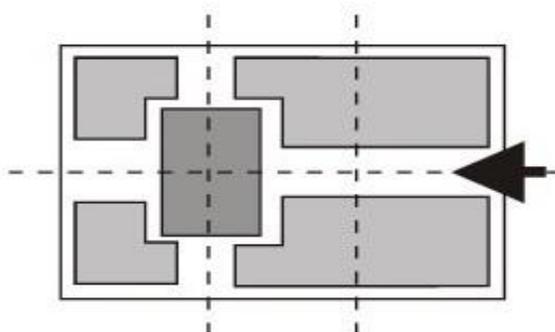


Figure1: Chaharbagh, Arc type of Persian garden

Pavilions with various forms are the only extrovert buildings in arid regions; they were used as residential places for monarchs or for royal ceremonies during summer days. Although there are many similarities between pavilions of Persian gardens in different arid region, the reason could also be the similarities in tradition, but climatic condition is the main cause of differences between them. The main goals of this paper are investigation of differences between the microclimatic features of selected pavilions as case studies, and also to determine various sustainable design aspects of Persian gardens' pavilions.

2. Research Methodology

The research methodology of this paper is descriptive-analytic method, based on historical and documented sources studies and includes these processes:

- The study of garden pavilions' typology in arid regions and selection one of the famous pavilion from each type as a case study.
- The analysis of climatic conditions of locations of selected cases by the Koppen's method with the usage of data of synoptic tables of Iran's weather website.
- A comparative study on selected pavilions and analysis them from sustainable view.

3. The Typology of Pavilions of Persian gardens in Arid Regions

In this research, the typology is based on the shape of pavilion's plan. The shape of garden's pavilion depends on several factors; such as shape and size of garden, topography of the site and climatic conditions. Since the Persian garden's pavilion is surrounded by trees and located in the garden which is acted as a closed ecosystem, in spite of other traditional buildings in arid regions, it is extrovert. There are four types of plans of Persian gardens' pavilions in arid regions; rectangular, square, octagonal and semi-octagonal shapes (table1) and in this paper the selected pavilions from each type are Chehelsotoun, Fin, Jahannama and Dolatabad which are located in Isfahan, Kashan, Shiraz and Yazd

respectively. These buildings like many Iranian pavilions were usually used for monarch enjoyment and royal ceremonies during summer days, also in Dolatabad garden there were two kinds of pavilions, used for winter and summer days. In this paper the summer pavilion will be analyzed.

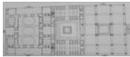
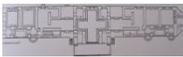
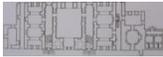
Type	Shape of Plan	Kinds of Plans			
1	Rectangular				
		Chehelsotoun	Shazde	Eram	
2	Square				
		HashtBehesht		Fin	
3	Octagonal				
		Ghadangah	Jahannama	Mosalla	Nazar
4	Semi-Octagonal				
			Dolatabad		

Table1: Typology of Persian Gardens' Pavilions in Arid Regions

4. Climatic Conditions

In Iran, there are many different geographical locations and climatic regions, each having special characteristics; as a result Iran is like a little continent. Iranian scientists have worked on different climatic classification, and the most widespread method is by dividing climate of Iran based on Koppen's method, which has classified the world's climatic into five zones: Hot-Humid (A), Hot-Arid (B), Temperate (C), Cold (D) and Polar (E) climate. There are a few countries in the world, which contains the main four climatic zones (A, B, C and D); all of these climatic zones and their deviations can be found in Iran. The climate of central Iranian plateau is arid and semi-arid, and receives almost no rain for the six hottest months of the year. The main characteristics of this climate are also a very arid summer and cold winter. Furthermore, in this areas, most of the time, the sky is cloudless and the air does not have any humidity. Thus there are large differences between days and night temperature. According to the Koppen's classification, the arid climate's classification is based on: annual temperature, humidity and amount of rainfall, and is

divided into four main microclimates: BWhs, BWks, BShs and BSks (Fadaie, 2009). According to Koppen's classification (Table2), all the selected cities are located in arid regions (BW). The mean annual temperature of Isfahan is under 18°C and in the other cities is over 18°C. Also the amount of rainfall in all cities (Table2) reveals that, in the wettest month of winter it is at least three times more than the driest month of summer. Therefore it could be concluded that, Isfahan can be accordingly classified as BWks microclimates and Kashan, Shiraz and Yazd are located in BWhs microclimatic areas. Moreover, Kashan is the most humid city and Yazd is the least one. In Isfahan the annual wind direction is often southwest and west, In Shiraz and Yazd are northwest but in Kashan, wind blows from all direction with low velocity.

city	Altitude	Annual Temperature	Temperature in Hottest Month	Annual Humidity	Annual Rainfall in Wettest Month of Winter	Annual Rainfall in Driest Month of Winter	Annual Rainfall in Wettest Month of Summer	Annual Rainfall in Driest Month of Summer	Conclusion
Isfahan	1550	16.6	29.2	35.5	46.3	4.4	1.5	0	BWks
Kashan	982	21.2	31.6	41	36.9	30.9	2.05	1.2	BWhs
Shiraz	1484	18.8	31.2	37.8	147.3	15.3	2.7	0	BWhs
Yazd	1273	18.9	43	26.4	10.47	10.25	1.03	0	BWhs

Table2: Climatic Conditions of Isfahan, Kashan, Shiraz and Yazd

5. The Parameters of Sustainability in Pavilions' Design

5.1. Location and Orientation

The pavilions of Persian gardens are located on the main axis, from centre till end of the garden. In Chehelsotoun garden, the pavilion is placed on the 1/3 end of garden and it's been completed during a process of time. In the first phase, the extension of pavilion was alongside the north-south axis. In the next phases, the additive parts were attached to the east side of the building. These additive parts caused to extend pavilion in the southeast orientation (Figure2).

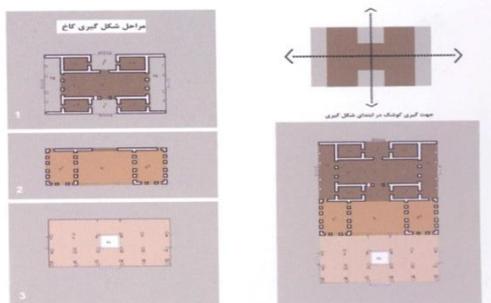


Figure2: The Process of Chehelsotoun Development

In Fin garden, the pavilion is placed almost in the centre of garden to utilize breezes from all direction, and is orientated to southeast. The Jahannama pavilion's location is the centre of

garden and it is orientated to Southeast as well, and ultimately, In Dolatabad garden, the main pavilion, used as summery residence is located on the southern side of garden and for usage of breeze, all its openings are opened to north and northwest and the building is orientated to southeast. All of these selected buildings are orientated to southeast. The southeast orientation of the garden would increase morning sun exposure and also would reduce the afternoon radiation (Fadaie, 2009).

5.2. Architectural Elements

5.2.1. Iwan and Balcony

Iwan is a single vaulted hall which is opened into the outside and acts as an entrance space of pavilion and connects building to the garden. The balcony is an isolated part of pavilion. The balconies usually placed where they could have a panoramic view while remaining invisible to the eyes of strangers in the garden (Gharipour, 2009). In spite of similarities between selected pavilions, there are differences between the number and extent of iwans and balconies. As table2 indicates, in Isfahan the coldest city, Chehelsotoun pavilion has the largest iwan, which it's extent approximately 2/3 of pavilion's area and opened in to three sides to use pleasure weather of garden and in the most humid city, Kashan, the garden's pavilion with the four iwans and twelve balconies has the most numbers of semi open spaces to flow humid weather in to the pavilion. The directions of wind from all sides in Kashan are the reasons to locate iwans and balconies on four sides of the building. In Dolatabad pavilion in Yazd, because of local dusty winds there are few iwans and balconies (3iwans&2balconies) opened to the outside.

5.2.2. Water pond and Stream

Water acted as a key ingredient in garden's pavilion design. Water is used as an important design criterion to create a comfortable microclimate in Persian gardens by channeling breeze over the existing water to reduce air temperature and to increase humidity. There are different ways of designs by water, which is displayed in all selected cases. Water pond, canal and streams, located inside and around the pavilions and various forms of fountains are demonstrated. The fountain is not just utilized for environmental beautification, but also to increase humidity during hot days. In all selected gardens, there are central ponds inside pavilions for evaporative cooling in spaces; especially in Dolatabad pavilion, the existence of high wind catcher on the top of pond would increase evaporative cooling (figure3).

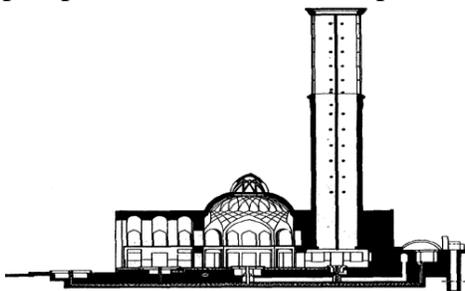


Figure3: Dolatabad garden's Pavilion with The Water Pond and Wind catcher

Although the physical effect of evaporation is essential, psychological effect of water is even greater. The sound of water inside the building is known to bring relief. Furthermore in all selected cases, the existence of water canals around the pavilions can modify airflow. Hot air can be cooled by passing over the water. In all of these pavilions the orientation of outside

water ponds according to wind directions. In Chehelsotoun, the pavilion was surrounded by water canals. In Jahannama pavilion, because of the location of building on 120cm platforms, the water from inside pond flows in to the outside ponds via four cascades. In Fin pavilion, the streams flow in to three directions, connect the building's central pond in to other pools, ponds and water streams in all parts of the garden and caused to increase evaporative cooling (Figure4) and finally, The directions of winds in Yazd are the reasons to locate the large pool and canal in the northwest of garden that ultimately caused to make evaporative cooling.

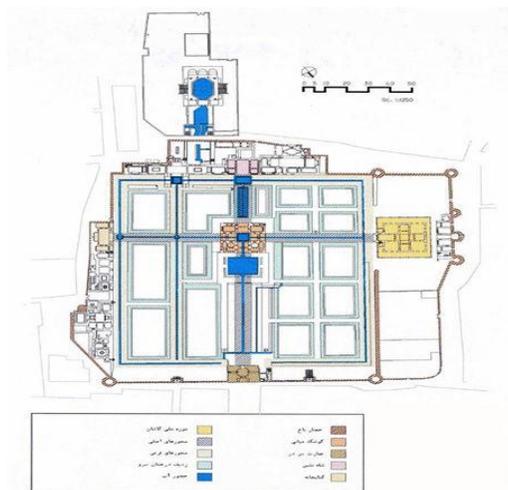


Figure4: the water streams and ponds inside and Outside of the Fin Pavilion

5.2.3. Roof Design

In spite of flat roof in Chehelsotoun pavilion, the form of other selected cases, just like other buildings in arid regions, are in dome form. Dome roof would shade part of its surface and also could shadow the other surfaces during the day. At night a domed roof surface area means the greater area from which long-wave radiation and heat loss can take place (Nielson, 2002).

5.2.4. Shading Devices

Usage of shading devices is an important strategy in sustainable design. They should be designed to reduce direct solar radiation and prevent reflection onto any part of the building or opening. In spite of Chehelsotoun pavilion which its large balcony is protected from direct sunshine by canopy, the other selected pavilions are protected from the intensity of sun by arcades and porches as shading devices.

5.3. Material

The main materials used in all selected pavilions are brick. Choosing brick has several factors to be considered: Brick has high thermal resistance, thermal capacity and sun absorption. It doesn't require a lot of energy to produce and also, it has the potential for reuse if the building is demolished. Furthermore, the tile' been utilized in some parts of pavilions; especially in Fin pavilion. Tile has also sustainable features; it can be changed and washed easily. These vernacular materials can be found resourcefully in arid regions (Figure5).



Figure5: The Tiled Arcade in Fin Pavilion

	City	shape	Location	Orientation	Roof Design	Shading Devices	Water Displays	Materials
Chehelsotoun	Isfahan	Rectangular	1/3 end of axis	NW-SE	Flat	Canopy	pond	Brick, Wood tile
Fin	Kashan	Square	Centre	NW-SE	Dome	Arcade	Pond	Brick, tile
Jahannama	Shiraz	Octagonal	Centre	NW-SE	Dome	Arcade	Pond	Brick
Dolatabad	Yazd	Semi-octagonal	End	NW-SE	Dome	Arcade	Pond	Brick

Table3: Characteristics of Chehelsotoun, Fin, Jahannama and Dolatabad Pavilions

6. Conclusion

By the analysis and a comparative method on the study of Chehelsotoun Fin, Jahannama and Dolatabad pavilions, the following conclusions can be obtained:

- The characteristics of selected pavilions reveal that, in spite of many similarities in design and elements, but being in different microclimatic regions, there are few dissimilarities between them. Climate even in a very close classification can be the main design determinant in the Persia gardens' pavilions.
- Orientation and spaces layout of the pavilions are as a results of, and employment of natural elements like: sun, wind and water, which have effective role to create Persian gardens' pavilions.
- The similarities between selected pavilions in this research in spite of their different types, reveals the same intellectual design principles in all Persian gardens' pavilions in arid regions.
- The usage of vernacular and sustainable materials (i.e. brick) with the high thermal capacity and resistance in the built space of the gardens (pavilion) in arid region reveals the importance and usage of sustainable materials in Persian gardens.
- In sustainable development model, considering to social, economic and environmental developments is suggested. Since society includes a group of people and environment includes, natural and built environments, therefore, in Persian garden's pavilion the

relationship between human, built environment and nature is based on model of sustainable development.

- The above concluding points can be applied to the region with the similar climate and configuration.

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