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Iranian traditional architecture and energy saving (case study: Shiraz Ghajar houses)

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Abstract
Climate is an important factor in logical formation of urban structures and their type of architecture. The present study looks at the relationship between the traditional buildings and sustainable development as well as the climatic conditions and construction patterns in Shiraz, Iran. The purpose of this research is to help promote energy efficient architectural design in Semi hot-arid climates by introducing the technics that the traditional architects used to design buildings in Shiraz. The climatic design solutions studied in a number of traditional buildings Belong to Qajar era in Shiraz. Result of this paper; show that considering the experience in traditional architecture of Shiraz, it is possible to create an environmental and sustainable architecture.

Keywords: Iranian traditional architecture; Vernacular architecture; Hot-arid zone architecture; Shiraz houses.

1. Introduction

The International Energy Agency projected that world oil production will peak as early as 2025, and at that time there would be significant increases in oil prices. As a result, buildings will need to be more energy efficient than they currently are, and designs should begin to rely more on renewable energy resources to meet the energy needs for buildings. One of the areas to look for energy-efficient architecture might be to go back and reinvestigate traditional architecture [1].

With the growth of population, more resource and energy is absorbed and as a result environmental population increases. The energy crisis and global changes in environment caused sustainability to become the main concern of human.Sustainable Architecture seeks to find solutions concerning the effects of human activities on environment and urban areas. Vernacular architecture has many solutions to offer to new sustainable developments because of its responsiveness to the environment [2].

Iranian traditional designers created exclusive buildings whose beauty was considered as well as their usefulness and sustainable functions when facing unfavorable environmental conditions. These issues were so important in Iranian ancient architecture that locating a city, positioning the buildings concerning the sunlight direction and major winds, the direction of the city extension, the directions and forms of paths, the locations of squares (for passing the air through passages, markets and houses) were all chosen very carefully and in relation to the region's climate [3]. Using architectural methods based on climate and local materials has damaged the environment as little as possible.

2. Methodologies

This research has been carried out through observing and studying previous studies regarding specifications of Iranian traditional architecture in Shiraz. In this paper we introduce some of Iranian traditional and sustainable features in old buildings in semi hot and arid regions and try to suggest some new ways to have these elements in our modern buildings again.

3. Sustainability

Sustainability in architecture means conserving constructions for the future, in terms of physical durability planet protect conserving on energy resources. 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 [4].

Environmental impact of human activities, pollution, overpopulation, widespread infrastructure deterioration, natural resource depletion and waste generation are some of the reasons that make sustainability as an essential approach in contemporary world [2].

A sustainable designing concept invites our effort to create the maximum amount of comfort for people by scaling up the standard of living and produce the least volume of damages to the environment. By paying attention on Iranian traditional architecture we could conform that its rules suit buildings in best way in sustainability and in correspondence to the local cultural, topographical and climatic conditions which have the least adverse effect on environment as well as design consistent with nature by obey its rules [5].

The major goals of sustainable architecture and its resulting sustainable development are to provide for the basic needs of mankind, to improve the standard of life, to better preserve and maintain the ecosystems and natural energy resources and finally to reach a safer future [3, 5].

4. 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.

This attribute draw a connection between the architecture and the climate and demonstrates a physical and architectural characteristic in a particular region [6].

Characteristics of this climate are as follow:

1. Hot and dry climatic in summer cold and dry in winter.
2. Very less rain.
3. Few trees and plants.
4. Less humidity.
5. High difference in temperature between day and night.

Shiraz has a semi hot-arid climate and we are going to introduce the technics that the traditional architects used to design buildings.

5. Architectural concepts

However there is a hard climate in this region, Native architects have used suitable methods and techniques for creating desirable environment for live and all designing techniques were used to increase humidity and to reduce temperature. There had been numerous creative climatic planning in order to use energy efficiently. Studying of these and combining them with new climatic systems can be a proper way to make the building more sustainable.

5.1 Court-yard

Yard is the main central area in hot-arid buildings (Figure 1). Low yards and water ponds in the middle of the yard make it possible for everyone to enjoy maximum pleasant weather.

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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. 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 [4].

Figure 1. Abedi house court-yard

5.2 Water pool

In hot, arid climates, the water from courtyard pools and fountains cools as it decorates. Water can not only reflect architecture and multiply the decorative themes; it can also serve as a means of emphasizing the visual axes and create a microclimate [7].

In this climate humidity is low; water increases humidity of the environment and thus prevents severe heat in day and severe cold at night. As humidity increases, plants can overcome unsuitable desert conditions and maintain their green structure. In the intersecting point of streams, there are ponds which both provide humidity and act as resources for low-water conditions [8].

5.3 Windows

Generally in hot and dry regions windows are small and are located in the upper parts of walls just near the ceiling. Although external walls do not have so many windows there are so many of them on the yard facing internal walls. Passing ventilation is done by these windows [9].

Colored panes allowed for a further diffusion of light and privacy in buildings. Using colored windowes which filter the light entering through windows is commen in hot-arid climate buildings (Figure 2).

Figure 2. Colored windows in Abedi house

5.4 Veranda (Iwan)

Often time's traditional architecture will have a unique room known as an 'Iwan'. Veranda is spaces within the building where one side is entirely open to the outdoors, typically a courtyard, to allow for privacy and security (Figure 3). This open side of the semi-enclosed rooms allows for light to enter the Veranda and the spaces beyond. Most typically iwans are located on the south side of courtyards with the open side of the room being to the north. This allows for the Veranda to harness the indirect light of the northern sky without having direct light enter in.

5.5 Seasonal usage of spaces (Winter section, Summer section)

There is a yearly space in the houses at court yard and for this reason the north part is called winter section and the south is summer section. The inhabitants of the house move to northern part in winter and accordingly to the southern part in summer to adapt themselves to regional conditions. Mostly, the height of summer portion is more in these houses thus; the hot weather as ends up and the cooler one replaces it in the lower surfaces. For better air ventilation, wind-catchers and air vents are mostly located in the southern part of building [9].

5.6 Material

The common material for constructing huge wall in hot and dry regions include mud, mudbrick, stone, brick, mortar, lime and wood (Figure 4). The thermo- physical specifications of these materials are the

important factors in hot and dry regions. These materials have thermal resistance, high heat capacity and they absorb the sun radiation by their external surfaces. The microscopic and many pores of the mentioned materials, which are filled with air, change them to a material similar to thermal insulator [10].

Figure 3. Forogh Al Molk house's veranda

5.7 Basement

One of the commen ways of the traditional architecture is using underground spaces in Shiraz city. This space used when the temperature was not favorable and try to prepare more appropriate thermal conditions for the users in summer. Basement Temperature is lower than outside temperature. Hence basement space can use for food storage in the summer, and in some cases used to live because of the benefit of its optimal temperature. Today one of the main benefits of buildings with basement space is energy efficiency. The use of this property of the soil, in the hot-arid climate leads to energy savings.

5.8 Pool house (hozkhane)

We can use the evaporative cooling of water in different ways to cool the air of a house in the summer (Figure 5). One of these ways which used by traditional architect is hozkhane space. This space is often covered and has high ceiling. Pond and fountain are in the middle of this space. The vents on the roof will accelerate the air flow. Around this space there are platforms for sitting. Sometimes the opening of wind- catcher opens in this space directly. By passing the air over the water fountain, cooled air is directed to other spaces in the house.

5.9 Wind catcher (badgir)

In ancient times and in traditional buildings in arid and dry regions the air trap functioned like the present modern air conditioning system. Wind-catcher is like a chimney whose end is in the underground and the top is set over a specific height on the roof and were built at the entrance of the house over underground water reservoirs or ponds built inside the house. The working process of a Wind-Catcher is much alike to modern water coolers. When a breeze enters a Wind-Catcher it is channeled to above a pool. After being exposed to water and evaporation (a heat absorbing process) which result in a cool breeze it's directed to the summer rooms [5].

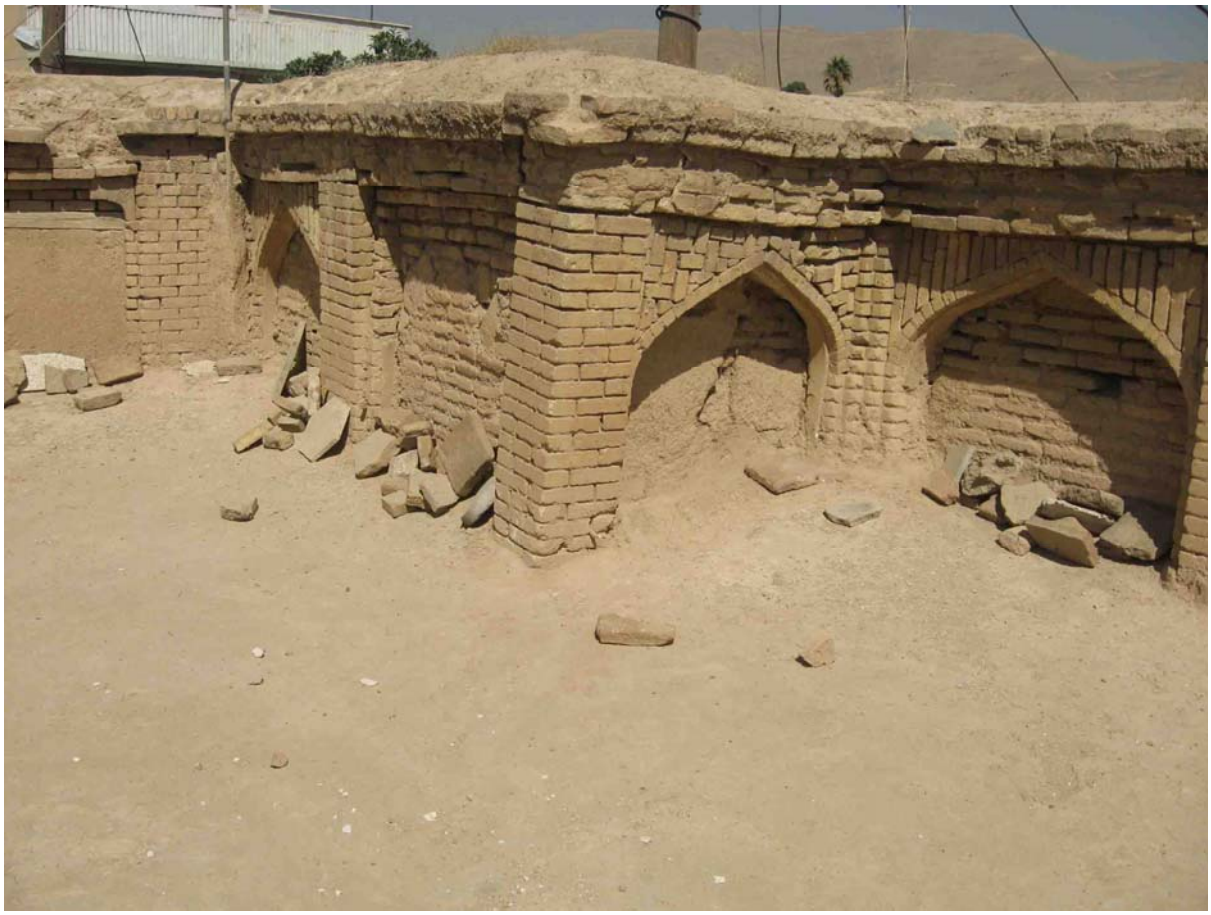

Figure 4. Thatch roof, Abedi house

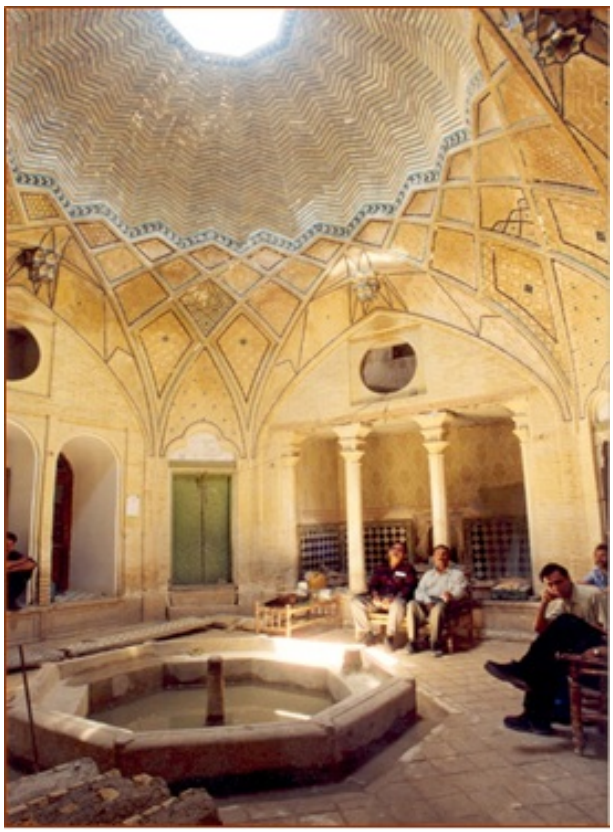

Figure 5. Forogh Al Molk hozkhane

6. Conclusion

Vernacular architecture of Iran has many characteristics of sustainable architecture. Studying its space helps to the future development as a successful space in the the city. Using natural resources, reducing energy consumption and providing comfortable, healthier and sustainable living spaces are the aims of a climatically responsive sustainable building design.

Sustainable architecture in Shiraz has been a strategy for improving the life quality and comfort. At the moment, environmental architecture is in focus in the world. In this type of architecture, main environmental issues are considered. Some of these issues include: controlling environmental conditions by using natural systems as far as possible, reducing energy consumption in the process of materials production, construction and applying economical facilities by the residents, using clean and recyclable energies (passive energy), etc.

In contemporary Architecture of Shiraz, the above items cannot be found any more. Perhaps a practical modern solution would be mixing the advanced technology and local knowledge to be applied to control climatic conditions. Architecture of Shiraz surround a large bulk of knowledge and experiences considering the usage of natural systems to balance proportionate conditions (temperature, humidity and fresh air flow) in the buildings. Traditional buildings in Shiraz have been constructed on the basis of using natural energy resources –both in architecture and in construction.

The climatic design solutions studied in a number of traditional buildings Belong to Qajar era in Shiraz, which presented in Table 1.

Table 1. The climatic design solutions in Shiraz house

Construction Name	Court-Yard	Water Pool	plant	Winter section, Summer section	Basement	windows	Veranda (Iwan)	Wind catcher	hozkhane	Vernacular materials
NasirAL Sadat	*	*	*	-	*	Colored panes-Reticular	*	-	-	Stone(Plinth)-brick-Thatch (roof), wood
Basir Divan complex	*	*	*	*	*	Reticular	*	*	*	Stone (stair and Plinth)
Abedi	*	*	*	*	-	Colored panes-Reticular	-	-	-	brick-Thatch (roof), Stone (Plinth)
Atrvash	*	*	*	-	-	-	*	-	-	brick-Thatch (roof), Stone (Plinth)
Tavakoli	*	*	*	*	*	Reticular	*	-	-	brick-Thatch (roof), Stone (Plinth)
ForoghAl Molk	*	*	*	*	*	Colored panes-Reticular	*	-	*	brick- Stone (Plinth)

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