International Scientific Journal
Architecture and Engineering
http://architecture.scientific-journal.com

Particularity study of sustainable architecture in Iran traditional architecture

Khosro Afzali[1*], Akram Moarefzade [1]
[1], Dept. Of Architecture, School of Technical Engineering
Islamic Azad University, Shushtar Branch,
Shushtar, Iran,
e. mail:khosro.afzali@gmail.com

Kaveh Afzali[2]
[2]Civil engineering Division
Iranian Gas Company,
Ahvaz, Iran.
e. mail:kavehafzali@yahoo.com

Abstract- **In the course of formation of the Iranian traditional architecture, ecological designed buildings have been developed because of the existence of the various climate conditions. Due to the necessity of confronting with undesirable environmental conditions, and to reaching the purposes of the sustainable architecture, the use of valuable experiences in design and construction of old and ancient buildings is unavoidable. This article studies the ancient texture of Shiraz as a case study for approaching Iran traditional architecture to sustainable architecture.**
Shiraz is located in south of Iran with cold and dry winter and hot summer with relative low humidity. This climate condition is cause of development of a condense population texture along east to west in order to use of desirable wind and satisfactory sunlight. The buildings are designed with a square plane, central yard, using thick brick wall and indented extensive window to proper air conditioning and receiving sufficient light. Overall, these parameters approach ancient texture of Shiraz to sustainable architecture.

Key words- traditional architecture ; sustainable architecture; climate; Shiraz

I.INTRODUCTION

Sustainable design or environmental design is a kind of design procedure in which designing objects and buildings is based on a kind of agreement and conformity with financial, social principals and climatology relations. In other words, the concept of sustainable design is omitting harmful environmental effects using a skillful design, the crystallization of which can be observed in not using non-refreshable energy resources, relating human with natural environment and the minimum effect of human on surrounding environment [1]. On this basis, sustainable architecture or environmental architecture can be considered as design and structure on the basis of environmental considerations and by using local and regional materials. By starting settlement in Iran, considering the climate has always been an important principal in designing and execution of buildings. Therefore sustainable architecture has a thousand-year record in Iran. By emergence of modern architecture and increasing usage of mechanical establishments, the importance of climate in architecture was not considered as before [2]. But considering the increase in energy price in the world, cities pollution and irretrievable damages of fossil fuels on environment, paying attention to climate and sustainable design is an inevitable task. Therefore, we have tried in this article to study the effects of climate factors in sustainable architecture by a review on traditional architecture studies and occasional study on Shiraz traditional texture.

II.SUSTAINABLE ARCHITECTURE STUDIES

In Iran's traditional architecture, according to geographical situation, building encounters with outside environment in a way that it make the best comfort of interior space possible without using complicated energy consuming and polluting equipments, through ceilings, decreasing external surfaces against direct sun radiations, creating shades, ventilations and undergrounds, central yards, shading parapets, windows toward sunlight, choosing appropriate materials for ceiling, wall, etc.
Creating heat balance between human's body and the surrounding environment is one of basic needs for comfort. For having this balance the body temperature should be fix or have little changes. Creating such a balance depends on various

factors, the most important of which is climate factors including air temperature, radiation of sunshine, comparative humidity and wind [3].

The effect of sun radiation on interior temperature of a building depends on the specifications of used materials in its external walls and the type of used materials has a great effect on providing comfort area for residents. Increase in outdoor temperature will warm up the exterior surfaces of external walls of the building. Temperature fluctuation of interior surfaces to external surfaces depends on heat capacity and resistance of wall materials and the higher the heat capacity and resistance of a wall, the lower is the fluctuation of interior surface and the time of reaching to minimum and maximum temperature of interior surfaces to outdoor air will be delayed. Decrease in temperature fluctuation of interior surfaces of a building to its exterior surfaces is in accordance with temperature resistance of its wall materials, but delay in the time of creating maximum and minimum temperature of interior surfaces to the time of exterior surfaces depends on heat capacity of wall materials. Heat temperature of materials depends on their special weight in addition to their material. Furthermore, heat capacity of walls depends on thickness of materials too, the higher the heat capacity of a wall, the slower the external heat is transferred toward inside, and therefore it increases the delay time of interior surfaces reaching to their maximum temperature in comparison with the exterior surfaces. At night, the heat reserved in building's material will be released with high heat capacity and will decrease the transfer amount of interior air heat to outdoor and is appropriate for areas with high daily temperature variation. Heat resistance of a wall includes the resistance that the wall creates against transferring heat from one side to its other side, therefore fluctuation of walls' interior surfaces temperature of a building depends on heat resistance of materials of these walls. The lower the coefficient of heat transfer in materials, the higher will be the heat resistance of those materials and therefore the transferred heat from that wall will be less [3, 4].

Actually, it is observed that the effect of walls thickness in controlling the surfaces temperature and interior air temperature of a building also depends on natural air ventilation conditions in that building and the color of exterior surfaces of walls. When the color of exterior surfaces of walls is dark, the maximum temperature of interior air of the building is deceased with thickness of walls. But when the outer surfaces are white, since almost a great amount of sun's radiation is reflected from the wall's surface, and only a little amount of its heating energy is absorbed by wall, the wall's thickness has not significant effect on controlling the maximum temperature of interior air. But in both mentioned states, the minimum temperature of interior air of building will increase with wall's thickness increase and exterior color of walls do not have any effect on this heat increase. Also, the heating condition of buildings inside that outdoor air is circulating in it depends on two factors, heat transfer from walls and natural air ventilation conditions. When the exterior color of walls is light, the effect of natural air ventilation will affect the walls' thickness function and when the exterior surfaces are dark, the probability of heat transfer from walls to interior air of the building will highly increase therefore wall thickness will have great importance in controlling heat conditions of interior air . On this basis, during the day, the buildings made of heavy materials will transfer less heat toward inside than the buildings made of light materials. Building made of light materials will get cool at evening and will provide better interior conditions than buildings made of heavy materials. But we should take in mind that in the afternoon that the outdoor air is cool, we can make the indoor air cool by making effective ventilation in building made of heavy materials and provide suitable condition in it [3].

The wind speed and temperature depends on each other in heat transfer by transaction. Continuous flow of wind inside roofed spaces, will cause the evaporation of sweat caused by heat and humidity in contact with body's surface and will create a noticeable coolness on skin surface. Lack of airflow in environment, will increase the temperature and humidity and will create a stuffy condition for the residents and inside heat and humidity of building will increase in comparison with outdoor space. Therefore, the direction and establishment method of the building plays a principal and effective role [3].

III. SUSTAINABLE ARCHITECTURE IN TRADITIONAL TEXTURE OF SHIRAZ

Shiraz is located at latitude of 29 degree and 32 minutes north, and longitude of 52 degree and 35 minutes east with height of 1491 meters from sea level in warm and semi desert climate. Warm and semi desert climate of Shiraz has created a hot summer with maximum recorded temperature of 43 C. In absence of clouds, because of direct sun radiation, humidity is low and a cold winter with minimum temperature recorded of -14 C. The high difference between day and night temperature, presence of high fluctuation of temperature in day and blow of prevailing wind with various speeds in different seasons from western north to western south and also blowing of local winds according to day and night from mountains side to the plain and vise versa, are of Shiraz climate situations. Nevertheless, location of Shiraz among Zagros mountainous stockade and also presence of gardens at north and western north of Shiraz, caused the weather moderation of Shiraz. The meteorological statistics results of this city show that the annual medium temperature of Shiraz is 17.3 C, winter and summer temperature difference 16.8 C, and humidity maximum 78% and minimum 15% [4, 5].

Raining in Shiraz is affected by periodic wind blow from Indian Ocean and is mostly unregulated. Annual medium raining in Shiraz is 367 mm. The least recorded rain is in summer and the most is in January. The great amount of raining in Shiraz is between November to April. Most of days wind blows from south to north with low intensity and 10 to 20% of days wind blows from west to east or from west south to east north with higher intensity. Wind blows rarely by low speed from east north and east and east south [5].

Natural ventilation from one side and wind flow speed in indoor space from other side, will affect human through affecting the temperature, humidity and interior surfaces of the building. Creating natural ventilation in building depends on pressure difference that wind blow creates in its interior walls and the wind flow, which is created in the interior space because of temperature difference of different surfaces of a building, is trivial and insignificant. Therefore, it is only wind blow, which affects on natural ventilation and interior temperature of a

building and therefore on the residents' comfort [4]. Nevertheless, since because of warm air entrance inside the building during daytime, the changes in interior air and outdoor air will be placed at same level. We should minimize the natural ventilation in the building on daytime. On the other hand, since humidity is low, with a low speed air flow, there is the possibility of decreasing the body temperature through sweat evaporation [6].

One of the most significant climate parameters of Shiraz is the high fluctuation of weather during day. This intense fluctuation will make the usage of heavy materials possible, in a way that the parts used in day should be built with heavy materials with high heat capacity. Materials such as brick, stone, cement are condensed and compacted and can answer this necessity [5].

Considering the high fluctuation of temperature during the year in Shiraz, the best structural form is a form, that lose the least temperature during winter and receives the least heat from sunshine and surrounding environment during summer. Therefore, square plan is considered the best building form, since, although has the highest volume, has the minimum exterior surface. Also considering the prevailing wind direction and the sun radiation direction, the appropriate building form expands along east-west axis. For preventing temperature loss of the building it is better that, there be more shared walls between buildings. Therefore the condensed and compacted textile in cube shape is more appropriate. Also according to summer conditions, buildings should be cubic, condensed, high and toward inside. Anyway by creating a hole in this cube and simultaneous use of plants and water in this hole, an appropriate space can be created in the building [4, 5]. For acquaintance with the usage method of sustainable architecture in Shiraz traditional architecture, two residential houses in this city are studied.

A- ATROOSH HOUSE

Atroosh historical house, which is in Eshagh Beik neighborhood and on eastern wing of Haji old bazaar, belongs to Qajaries era and is recorded in National Works List on May 20, 1975. This house is considered unique according to tile-work and oil paint painting of ceiling. Considering the location on site (Figure 1), it is observed that the whole texture's direction is in east-west direction inclined toward east. The building form in this house is as a condensed cube which an L shape plan with two wings toward south and east is created by creating a hole (yard) on its east south corner. In this way the plan is introvert with central yard which is declined toward inside. The main part of building or in other words a part of building in which the main daily activity take place, including living rooms, bedrooms and Panjdari are located at wing toward south and service parts including kitchen, storehouse and stairway are located at wing toward east.

Presence of two-floor building and high walls of the yard will create shadow in yard and buildings body. Also using plants and water in yard through creating microclimate will cause air purification and reducing the effects of direct sun radiation and air heat so that the residents would use the yard space and perform some of their activities in the yard. Creating horizontal and vertical shades on openings by using fossa and dragging, will prevent direct sun radiation in summer and let enough light inside in winter. Thick brick walls with high heat capacity and low heat transfer will prevent undesirable heat transfer inside and outside the building (Figures 2&3).

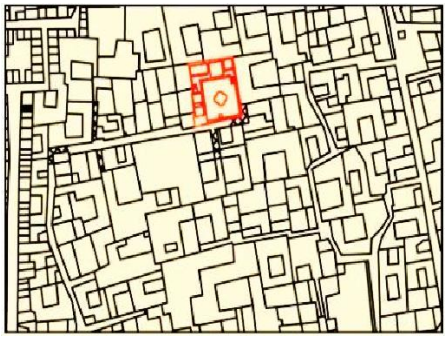

Figure 1. The position of Atroosh house location in Eshagh Beik neighborhood of Shiraz old texture.

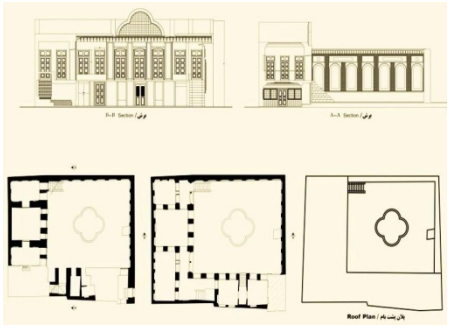

Figure 2. The plan of ground floor, first floor, roof side and section of Atroosh house

Figure 3. Use of high walls, water and plant and fossette and dragged openings in Atroosh house

B- KARIMI HOUSE

This house is also located in Eshagh Beik neighborhood and in Haji old bazaar and belongs to Qajaries era. The buildings direction considering the locating situation in site (Figure 4) is in east-west form. The building's form is condensed cube that by placing yard in western wing of this cube a U shape is formed. In result of this form there is a winter-using space created in wing toward south, a summer-using space in wing toward north and a service space in wing toward west. As the previous study in this climate, in this house also a two-floor building with high

thick brick walls, fossette and dragged openings, plant and water elements in yard are used (Figures 5&6).

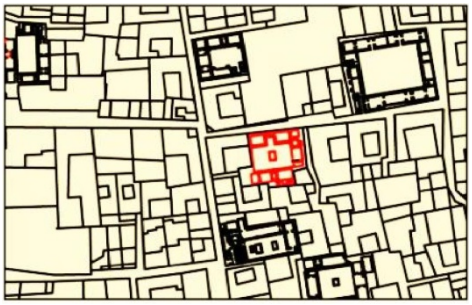

Figure 4. The position of Karimi house location in Eshagh Beik neighborhood of Shiraz old texture.

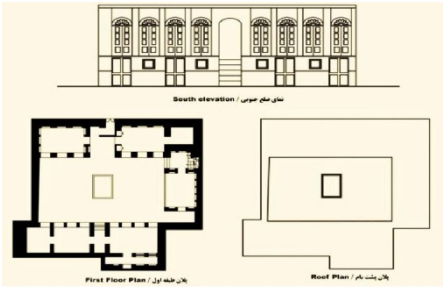

Figure 5. The plan of first floor, roof side and south facade of Karimi house

Figure 6. Use of water and plant and fossette and dragged openings in Karimi house

IV. CONCLUSION

Considering Shiraz as a case study of sustainable traditional architecture, it will be clear that the texture extension direction is in east-west direction for using desirable wind and sun light, and also condensed and compacted buildings for preventing heat loss and shading. Presence of introvert and square plans with high volume against low outside surface will cause a controlled heat transaction. In addition, presence of shared walls between buildings, height of walls and buildings and using the materials with appropriate heat exchange capability is for creating desirable environmental conditions for residents and opposing with undesirable climate factors. Furthermore, using dragged and fossette openings, desirable ventilation will make light taking and appropriate heat transaction possible. In addition, there is the possibility of reducing body temperature through sweat evaporation by a slow airflow. By observing most of Shiraz old buildings we can see that in most of the buildings, central yard had a remarkable role in buildings form and light taking direction in different seasons. In the way, that location of main spaces is toward south and north and services and store rooms and other parts in east and west part. On the other hand, the central yard can be used for residents' daily activities by using microclimates in them.

REFERENCES

[1] Wikipedia, the free encyclopedia. http://en.Wikipedia.org/wiki/sustainable_design.
[2] D. Watson, and I. Kent. Climate designing: theoretical and executive principals of energy using in building. translated by Vahid Ghobadian and Mohammad Feizmahdavi. 2005. Tehran: Tehran University Publication, 1983.
[3] S. Moshiri. Sustainable design on basis of warm and humid climate. Hoviat-e-Shahr publication 3. No. 4 (spring & summer 2009); http://www.sid.ir/fa/VEWSSID/J_pdf/38413880504.pdf (availability on Jan. 10, 2011)
[4] M. Kasmaei. Climate and Architecture. Edited by Mohammad Ahmadinejad. Isfahan: Khak publication, 2006.
[5] M.M. Falamaki. A Review on urban repair "From Venicia to Shiraz". Tehran: Faza publication, 2005.
[6] A. Moarefhzadeh. Designing residential complex in Shiraz traditional texture: Urban repair of eroded texture. Bachelor's thesis. Dezful: Islamic Azd University, 2008.
[7] Published documents. Cultural Heritage and Tourism Organization, Cultural Heritage Base in Shiraz historical city, 2007.