

Climatic responsive architecture in hot and dry regions of Iran

A. A'zami

Department of Architecture, Islamic Azad University of Tabriz, Member of ISES, ASES, IRSES

S.H. Yasrebi

Department of Civil Engineering, Islamic Azad University of Tabriz

A. Salehipoor

Department of Architecture, Islamic Azad University of Tabriz

ABSTRACT

Providing optimum cooling and heating of residential buildings of hot and dry regions in Iran so far has been according to the relations of ecology, so that using architectural methods based on climate, local materials and also culture has damaged the environment as little as possible. Iran's traditional architecture has been generated from a climate and the situation which it has grown on it, so that all existing spaces of these regions such as urban spaces of passages, yards, and buildings are protected against the atmospheric factors especially undesirable winds, and using desirable winds and the sun's radiation are done according to some special arrangements. In order to recreate the least sun light and heat, outer parts of building walls of urban texture of these regions are condensed to each other and the houses are thickly joined to each other. The lanes are thin and disordered and sometimes they are covered with quite high walls, it is believed that while these situations create a shadow against the sun's radiation they control the speed of Kavir (Salt desert) winds.

The idea of court yard in the houses of these regions has been formed according to the climatic factors, so that construction of courtyard houses of these regions with the indicators such as thick walls of porches, basements, wind catchers, arches and domes show that architects had an explicit concept of environmental conditions. Seasonal usage of spaces, concentration and attention to courtyard and making suitable use of roof are the very functional ways of planning which is in accordance with hot-arid regions. Lastly, we can say that Iran's traditional architecture is a constant and sustainable archi-

ecture, because with a stable indicator it is able to answer its ecological matters after the passage of so many years.

1. INTRODUCTION

Plateau plains, which are considered as the outstanding district of our country, are located mainly in central and eastern parts of country.

Being the biggest region and surrounded by high rough nesses the central plateau of Iran (Falat-e-Marakazi) has a dry climate. The two regions of Dasht-e-Kvir and Kavir-e-Lout – occupying one seventh of Iranian area- are located in the center of Iran, which is totally barren with a very little rain. High temperature in days of hot seasons, so much difference between day and night, extreme radiation of sun light, and relative dryness of atmosphere are considered as climatic specifications of salt desert areas. The air temperature of different domains of these regions depends on geographical situation, sea level altitude and wind direction. The habitable states of these regions are scattered with different distances from each other and are in the term

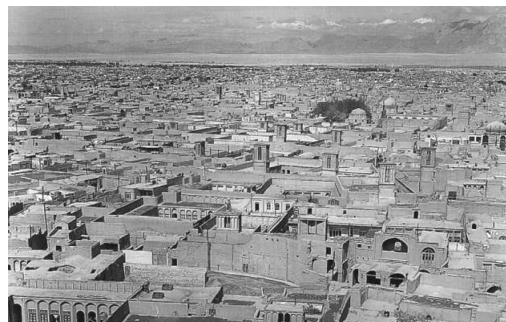


Figure 1: Yazd city view.

of condensed and centralized or concentrated. Thus, being in a harmonic architecture with the regions, the old habitable states and cities have been serving both as a residential complex and as an answer for material, spiritual and cultural needs of indigenous people. Beyond any doubt making use of intelligent will-power a natural gifts has lead to a constant life with the least damage to balanced order of region's nature.

2. CLIMATIC CONDITIONS

Hard and cold winters, warm and dry summers, very low rate of rain, air humidity, herbal cover, so much difference between day and night temperature and in salt desert and salt-desert border regions, the dusty winds are the outstanding climatic specifications in this region.

3. MORPHOLOGY AND URBAN TEXTURE

The villages and cities of hot-arid regions can be compared to cactus bushes or desert plants. Because the life spaces of these regions consisted of urban spaces, pathways, yards and buildings are completely protected against undesirable winds and at the same time desirable winds and sun radiation are used with special arrangements. The urban texture is condensed and compressed to each other in these regions. Houses have merged or combined walls and the border between them cannot be identified. The compression and combination of buildings has leaded the external surface of each building to the least and as a result each home can conserve the needed energy inside of it for a long time. It is also an answer for the crowdedness.

The narrow serrated lanes, which sometimes



Figure 2: Very dense texture in Yazd city.

have high walls and are roofed by arches, cast a shadow on the surrounding houses and control the wind speed of Kafir. The structure of city is planned in a way, which arteries are open in the direction of desirable winds and closed in the direction of undesirable winds and sand storms.

4. BUILDING ELEMENTS IN HOT-ARID REGION

4.1 Introversion (*Darungharaei*) and court yard

Being considered as the focal point, court yard is a social space with an environmental function. The lengthened and narrow form of this court yard, casts enough and needed shadow for this space during summer days. Commonly there is a *Godal Baghcheh* or below ground court yard, with different kinds of flowers and trees and also a shallow pond or to produce a fresh and cool place for inhabitants. Net counting the beauty it provides, by shading and increasing relative humidity it helps the comfort condition of yard and is one of the major elements of natural cooling system of the house. All openings and room entrances ends are the connecting space between all parts of house. On the one hand as the heat capacity of air is very low the court yard very soon adapts the temperature of surrounding environment (Fig. 3).

4.2 Roof

Using dome & arched roofs instead of flat roofs

The domes, which were used as covering roof for mosques, water reservoirs and Bazar (shopping center), are another type of roof in hot and dry regions. In addition to structured reasons, the dome shape roofing of buildings in this region has some thermo-physical reasons as well. Due to having convex and unbalanced surface the impact angle of sunbeam on dome and arched roof is different from one point to an-

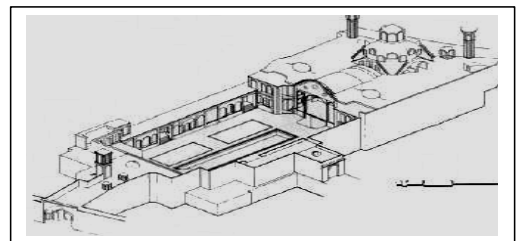


Figure 3: Courtyard of *Borujerdiha* house.

other, and a part of it always remains in shade during morning and afternoon times, for this reason the curved shape is suitable for releasing and emitting sunbeams and waves during night and it helps to the night cooling.

If the flat roofs are used in hot & dry regions it is usually paved with square shape bricks called paved bricks. These bricks receive the most radiations of sun. Early morning it starts to increase and late afternoon it decreases gradually. This action causes the change in sun radiation intensity and radiation angle.

4.3 Walls

Being considered as an important element in regional house of hot & dry climate, the huge walls have approximately thickness of about one meter. These walls lose the heat through transferring and radiation during night and its temperature remains in low and average degree during the day, thus, it provides enough comfort for residents.

4.4 Windows

Generally in hot & 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. Wind-catcher also helps to the internal ventilation.

4.5 Wind-catcher

By the help of experience, the people living in these regions have noticed that the intolerable

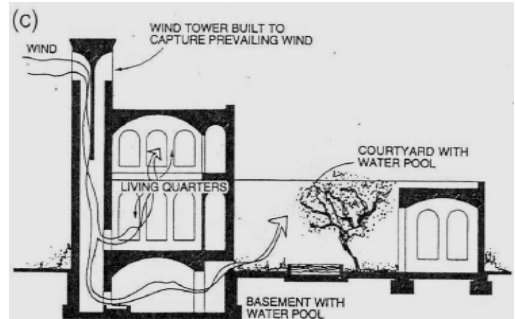


Figure 5: Way of wind-catcher function for ventilation of a House.

hotness of desert regions is because of land reflection, which excessively makes some matters of hot & brand air in the lower thin layer of land for this reason they have improvised a high air vent with at most 8 wings, for their houses, which is called Badgir or wind-catcher. Wind-catcher is one of the other elements of hot & dry architecture which is used for cooling and ventilation of internal spaces.

Wind-catcher is as constant complex which acts both by sucking & pulling. The basis of action is that wind blowing is used to suck the cold air to the inside of building and the reaction of it is used for sending out the hot and pollutant air from inside the building. Once the wind come in contact with walls of internal wings of wind-catcher inevitably it descends and enters the building space, on the other hand the holes or vents of wind-catcher on the opposite side of wind blowing to the sucking and give the hot & pollutant air of building to the wind.

4.6 Material

The common material for constructing huge

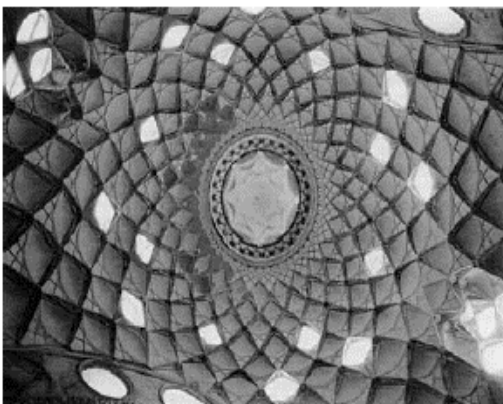


Figure 4: Vents in dome roofs for ventilation and cooling; hot & dry region.



Figure 6: A sample of Padiav (Godal Baghcheh) in Abou-ezid located in south east of Kashan.

wall in hot & dry regions includes mud, mud-brick, stone, brick, mortar, lime and wood.

The thermo-physical specifications of these materials are the important factors in hot & 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 material, which are filled with air, change them to a material similar to thermal insulator.

4.7 Godal Baghcheh in house yard

The depth of the yards was more than the normal to have access to Ganat water or subterranean canal of water, which was passing underground of yard, to water garden and below ground court yard. These yards were called Godal Baghcheh or Padiav. By having a cover full of plants and trees and naturally because of evaporation and sudation they are acting as a cool and fresh air generator for the upper yard spaces. The floor of the yard was paved with square bricks called paved bricks, which water and broom were used to clean them and it caused the yard space to become cool.

Increase of contact surface of building with earth

When a building is constructed without any excavation, the contact surface of it with earth would be equal to its area but once the excavation is done the contact size would be increase. In hot & dry regions to decrease the heat exchange of building with outside air and to pro-

vide low-expense and natural cooling and heating, the buildings are constructed in a pile of soil as much as possible.

4.8 Planting

In desert regions the rate of planting depends on water amount and way of accessing to it. In hot & dry region the herbal space lots of effects on the small surrounding regions for the following reasons:

1. Decrease of direct radiation of sunbeams and yard space.
2. Shading on ceiling, walls, windows, and yard space.
3. Decrease of dust in the surrounding environment of building.
4. Decrease of undesirable wind speed in building surroundings.
5. Concentration of wind blow and increase of its speed in a desired direction.
6. Increase of humidity in dry regions.
7. Decrease of temperature in building surroundings.

In most of the houses of hot-arid regions of Iran, wind catcher has a direct connection to parch and this space is used for diversity of functions from morning to noon and inhabitants use the underground in the afternoon and roofs at night, which have colder weather, for sleeping. In fact, this act of changing daily space is called local-regional correspondence.

It should be said that there is a yearly space in the houses at court yard and for this reason the north part is called winter portion and the south is summer portion. 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.

5. CONCLUSIONS

- Residential architecture of these regions is an expressive sample of ecological architecture.

Old architecture in hot and dry region is in accordance with region and regional factors

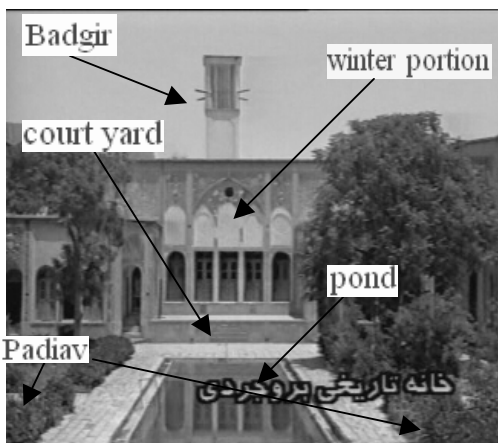


Figure 7: Some of important elements in *Borujerdiha* house.

such as desired and undesired winds, humidity, sun, etc. Planning each of the full and empty spaces like court yard with tall and shading walls, enclosed spaces, porches, rooms in different directions, corner rooms with wind-catcher and pond, basement and roof is for special hours of day and night of cold-average and hot season. And a person can change his/her living space in harmony with regional changes.

In addition to this, all traditional buildings of Iran, both in architectural and constructional fields, are planned in a way to have maximum of sun radiation during winter and maximum of shade during summer to use natural ventilation and to provide peace and comfort for the house residents. The houses of court yards with indicators like thick walls, porches, underground, wind catcher, vault and dome, are clear examples of architect understanding of environmental conditions.

- The urban morphology in hot-arid regions is the cause of condensed and concentrated urban texture in which the main arteries are facing the desired wind and opposing undesired one.
- In hot-arid region architecture of Iran the materials with heat capacity and resistance like mud, mud-brick and brick are used which are very effective in cooling and heating of internal spaces. These materials can be recycled thus, are very effective in the sustainability of Iranian architecture.
- Traditional architecture of Iran is called Organic architecture and is formed with extreme respect to site and geophysical specifications of earth. It is noticed that houses don't have equal sizes and dimensions and they also don't have a clear geometric form, through the architect tries to solve this geometric disorder in spaces but because of regional reasons court yard has a completely calculated dimensions, or in the planning of cities the lanes and city spaces are meandering and are planned with regard to natural phenomenon's of earth and sit thus, they don't have any geometric order.
- In this region the creation of court yard in the middle of building and preparing pond and flower-bed increases humidity in building environment and the mud-brick and brick

walls, which are made thick, due to heavy weight of arched and dome vaults, acting like a thermal condenser, decrease the variance of temperature during day and night. Finally by making all openings facing to relatively humid space of yard and blocking external walls of building (except entrance door), the internal and external space connection is cut as far as possible and a suitable microclimate is constructed for human comfort in hot -arid region.

REFERENCES

- Aghdabiglo, Z., Passive cooling system, PhD thesis, Sydney University.
- Ghobadian, V., 1998. Climatic Analysis of the Iranian Traditional Buildings, Tehran: Tehran University Publications
- Hyde, R., 2000. Climatic Responsive Design. E & FN SPON
- Mahyari, A., Wind catchers, PhD thesis, Sydney University
- Poor, J. and M. Reza, Design criteria for development of settlements in arid coastal region of Iran (case of study of Bandar Lengeh
- Tavassoli, M., 1983. City planning in the hot and dry climate of Iran. New York: G. Golanyed
- Tavassoli, M., 1974. Architecture of hot arid climate, Tehran: Tehran University.
- Yazd the Gem of the Desert, a tourist information guide-book, book one, Published and Distributed by: The society of Yazd Public Libraries, June 1997.