

The Experience of Iranian Architecture in Direction of Urban Passages and Forming of Urban Structures to Increase Climatic Comfort

N. Utaberta, N. Sharifi, M. Surat, A. I. Che-Ani and N.M. Tawil

Abstract—Iran has diverse climates and each have established distinct properties in their area. The extent and intensity of climatic factors effects on the lives of people living in various regions of Iran is so great that it cannot be simply ignored. In a large part of Iran known as the Central Plateau there is no precipitation for more than half of the year and dry weather and scarcity of fresh water pose an ever present problem for the people of these regions while in north of Iran upon the southern shores of the Caspian Sea the people face 80% humidity caused by the sea and 2 meters of annual precipitation. This article tries to review the past experiences of local architecture of Iran's various regions so that they can be used to reshape and redirect the urban areas and structure of Iran's current cities to provide environmental comfort by minimum use of fossil fuels.

Keywords—Urban Passage; Architecture in Iran; Urban Structure, Climatic Comfort

I. INTRODUCTION

IN the northern shores of the Persian Gulf and Oman Sea south of Iran, a region with very high temperature, humidity and low precipitation, hardships of life never ends. In the northwest and west mountainous regions of Iran, snowfall and freezing temperature impose another challenge for the residents. [1] Such effects of climate on the life of Iran's people causes any planning concerned with their lifestyle to consider climate factors. Therefore traditional architecture of Iran innovated methods and principles that without any mechanical means the environmental conditions of the buildings in various climates were brought to comforting setting for human life as much as possible, to such success that even today with all of the new materials and technologies which are costly and pollutant cannot provide the comfort of traditional buildings and structure.

Traditional architects were always trying to coordinate the main direction of buildings and urban areas southwards or towards suitable wind or any other direction which would provide the most comforting conditions for the residents. They paid utmost attention to comfort of the residents in designing the areas and relations.

Dr. Nangkula Utaberta IAI, was a Senior Lecturer and Profesional Architect at the National University of Malaysia, UKM Bangi Malaysia (phone: 60389217035; e-mail: nangkula_arch@yahoo.com).

Negin Sharifi was a PhD student at the National University of Malaysia, UKM Bangi Malaysia

Ar. Mastor Surat was a Senior Fellow and Profesional Architect at the National University of Malaysia, UKM Bangi Malaysia.

Sr. Dr. Adi Irfan Che Ani, was a Senior Lecturer and Profesional Surveyor at the National University of Malaysia, UKM Bangi Malaysia.

Dr. Norngainy Mohd. Tawil, was a Senior Lecturer at the National University of Malaysia, UKM Bangi Malaysia.

But nowadays that buildings are hot in summer, even hotter than their surroundings and cold in winter, comfort is almost forgotten and modern polluting and costly equipments are used to provide a semblance of comfort to the building. High costs of mechanical installations and their required energies and pollutions generated by these equipments, scholars and engineers in various countries are turning their attention to environment and each day a new innovation and method is presented. Renewable energy sources without pollutions such as solar, water and wind power and utilizing climate conditions to adjust temperature are some examples. Iran with its rich resources of fossil fuels especially natural gas and oil has been dependent upon this resource for energy supply ever since oil was discovered in its soil. [2] However, economic experts and planners believe that fossil fuel consumption must be reduced as soon as possible. Therefore extensive research to utilize the architecture experience of other countries and also successful experiences of Iran in the past seems to be necessary. This article tries to review the past experiences of local architecture of Iran's various regions so that they can be used to reshape and redirect the urban areas and structure of Iran's current cities to provide environmental comfort by minimum use of fossil fuels.

II. FORMING OF URBAN STRUCTURES AND CITIES ACCORDING TO CLIMATIC CONDITIONS

The most important event in the social life of Iran in the 20th century was the change in the lifestyle of people to move towards cities from rural areas, a rate of currently 70% and predicted to increase steadily in future years. With more than 700 cities and predicted 1000 cities in the next 20 years, if not managed properly will mean dramatic environmental degeneration. Changes in lifestyles during the recent four decades were accompanied by increasing consumption of fossil fuels or in other words, nonrenewable resources.

Change of habitats from homes to apartment, high density of population in cities and fast but semi-systematic or non-systematic constructions and the resulting increase in energy consumption to provide comforting conditions has made planners to determine polities to reduce the consumption of nonrenewable energies. [3]

One the effective factors on environmental comfort and reducing fuel consumption in houses is correct direction, method of establishment and general form of these buildings. In this regard various successful experiences are seen in the traditional architecture of Iran and therefore reviewing Iranian traditional architecture and utilizing their measures of adoption to climate can be very effective in using renewable energies and reducing consumption of nonrenewable fossil fuels.

These experiences considered five important climatic factors: Sunlight, wind, humidity, vegetation and geography.

Traditional architects, like other capable architects of the world, in order to achieve the intended comforting conditions, considered the following as the principles of climatic designing:

- 1) Reducing the effect of cold winds in cold regions and utilizing cool winds in torrid regions.
- 2) Minimizing the effect of sunlight in torrid regions and maximum utilization of sunlight in cold regions.
- 3) Creating slow air currents in urban areas and interior of the building in humid regions and conserving humidity in arid regions.
- 4) Utilizing vegetation and the geography of the region to adjust comfort factors

Based on these principles, the architects studies the climatic conditions of each reasons and planned the building accordingly so that gradually these designs became stable patterns in each region and every architect would bind him/herself to observe these patterns. The mentioned patterns determined specific frameworks for direction of passages and buildings, positioning of structures and their general forms.

III. CLIMATIC DIVERSITY OF IRAN

As mentioned Iran has diverse climates and without considering them it is impossible to design a successful urban and architectural plan. Diversity of Iran's climates includes temperate and humid regions of the north, ward and humid regions of the south, cold and mountainous of the west, warm and arid plains of the central plateau. In addition to the major climates of Iran, because of diverse regional conditions such as topography, surface waters, local and seasonal winds and etc there are various microclimates present as the subsidiary of the major climates of Iran which often does not follow the dominant climate of their region. [1] Microclimates in Iran are varied and their study requires a separate research. [1]

A. Temperate and Humid Climate of North

This region is the southern shores of the Caspian Sea with humid and temperate climate during winter and warm and humid during summer and is located in the north of Iran up to the northern steps of the Alborz mountain range. While this region is not near the equator, warm seasons bring about equator like weather. Also while climate is temperate and humid during winter, the high temperature and humidity of warm seasons is the factor most affecting the trend of residential and urban patterns of this region. Humidity of about 80% in all seasons and high precipitation reaching 1818 mm in some regions, low difference between day and night temperature and extensive vegetation are the characteristics of this region. The architects of this region always followed these objectives: [4].

Provide the most shade and minimizing heat absorption

- 1) Create air currents in urban areas and interior of the buildings

- 2) Protect building against heavy rainfall and the resulting humidity

In these regions the determining factor for direction of buildings was utilization of wind energy and had priority over the direction against sunlight. Confined urban areas without air currents in this region will result in accumulation of humidity which will cause breathing problems and severely degenerated comfort conditions. Therefore urban passages and structures were designed according to the mentioned objectives. In this region which is located near the shore, at daytime natural air current as a breeze blows from the sea towards shore and in the night vice versa. Therefore passages perpendicular to the shoreline would help provide almost constant air flow throughout day and night. On the other hand, constructing buildings with in-between spaces provided air flow among the structures. These spaces, especially those perpendiculars to the shoreline greatly helped to prevent accumulation of humidity in urban areas. Therefore the characteristics of urban structure of this region in the past can summarized as follows:

- 1) Expanded and spread structure (separated buildings)
- 2) Passages constructed aligned with air flow and creating air current in urban areas
- 3) Relatively vast urban areas
- 4) Relatively wide passes and alleys

Along these characteristics, residential buildings directions and general form in this region were those providing the most air current. Therefore many residential buildings in this region have east-west coordination and their southern and northern regions were in contract with open air. This was to utilize sea to shore and vice versa breeze throughout day and night to create air currents inside the building. By positioning windows opposite of each other in north and south sides of the building this current was established.

Along these characteristics, residential buildings directions and general form in this region were those providing the most air current. Therefore many residential buildings in this region have east-west coordination and their southern and northern regions were in contract with open air.

This was to utilize sea to shore and vice versa breeze throughout day and night to create air currents inside the building. By positioning windows opposite of each other in north and south sides of the building this current was established.



Fig. 1 Sky view of Bandar Anzali, North of Iran

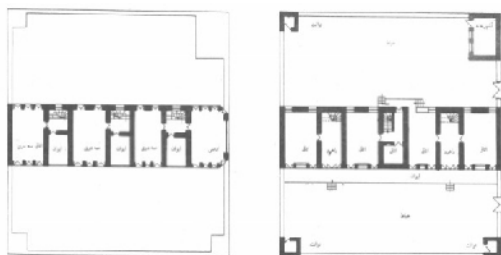


Fig. 2 A sample of a house in Bandar Anzali, North of Iran



Fig. 3 North of Iran, attention to width of house and windows

B. Warm and Humid Climate of the South

In addition to north, the south also experiences warm and humid climate with completely different temperature and vegetation and etc. compared to the north of Iran and instead of just summer, it is prevalent throughout the year. This region includes the northern shores of Persian Gulf and Oman Sea in the south of Iran. Life is very hard in these regions, long hot summers with high humidity along with low precipitation and scarce vegetation provide a challenging lifestyle for the residents. It must be noted that by just using climatic factors, providing comfort conditions in this region is very difficult and in most cases it is possible only through mechanical equipments [5].

But traditional architects of this region, whom sought agreeable living conditions, followed these objectives:

- 1) Constructing houses and urban areas perpendicular to wind direction and create air current and air flow in urban areas and houses.
- 2) Utilizing shades in urban areas and houses.

To achieve said objectives, architects expanded along the shoreline and positioned the buildings towards the sea to utilizing sea-shore breeze and also prevent humidity accumulation by construction a wide urban area. But because of intense sunlight and need for shades in urban areas, they compromised with semi-concentrated structure so that in addition to preventing humidity accumulation, shades could be made in urban areas.

Therefore numerous high walls to create shades and creating air pressure difference between sunlit and shaded side became a characteristics of urban areas of this region. In summary the properties of urban areas of this region are as follows:

- 1) Expanding of cities along shoreline and positioning them towards the sea
- 2) Semi-concentrated urban structure
- 3) Semi confined urban areas
- 4) Relatively narrow passages to create shade



Fig. 4 Sky view of Bandar Abbas, South of Iran

Residential architecture of this region is also formed by its unpleasant climatic conditions. Very high temperatures and need for shades drives architects to construct central yards to control climatic conditions and also humidity and prevention of its accumulation makes them to position windows opposite of each other towards exterior spaces, especially towards the shore line and its opposite (north and south of the building). High humidity and temperature of this region inclined the architects to construct semi-open spaces with shades and high balconies to prevent stagnant humidity to bother the residents. In summary, the characteristics of residential architecture of this region are:

- 1) Coordination of buildings along with shoreline to utilize most shade and air current
- 2) Using central yard and vast and high balconies
- 3) High and large windows to create air current

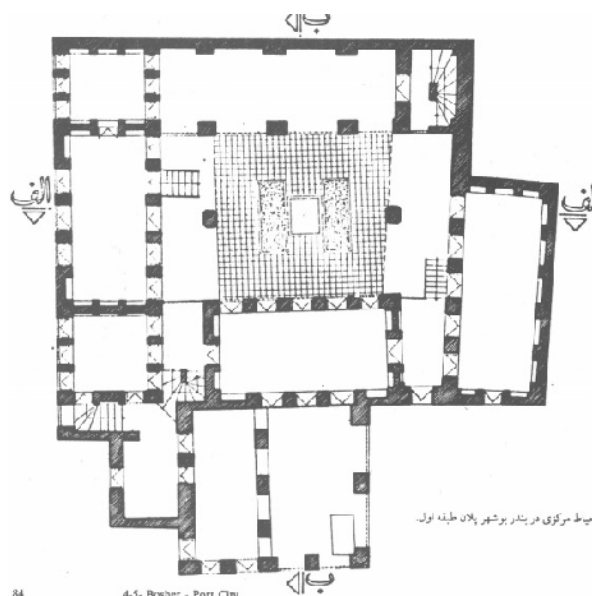


Fig 5. A sample of housing plan in south of Iran

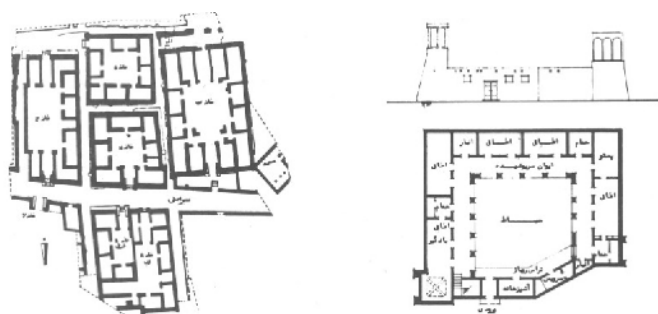


Fig 6. A sample of urbanism in south of Iran .attention to narrow alley and central courtyard

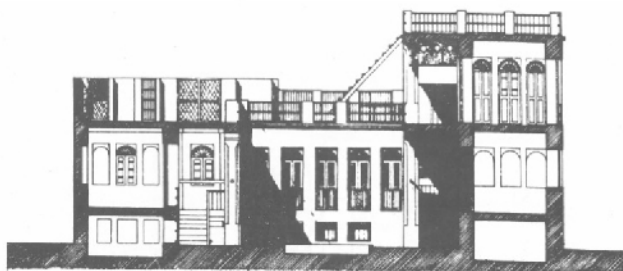


Fig 7. attention to difference height between rooms .low height of building do not prevent of ventilation

C. Cold and Mountainous Climate of West and Northwest

Alborz and Zagros mountain ranges respectively separate the shores of the Caspian Sea and the plain of Mesopotamia from the central Iran. Regions located in the steps of these mountains, especially Zagros, have quite different climatic conditions compared to the two already mentioned.

Severe cold in winter and relatively temperate climate in summer, heavy snowfall in the north and northwest regions of these mountains, low humidity and high difference of day and night temperature has made these regions completely different.

The architects of this region like their other colleagues adopted their methods according to climatic conditions and to provide the most comforting conditions which can be summarized in the following:

- 1) Maximum use of sunlight
- 2) Utilizing daily fluctuations of air and heat conservation
- 3) Preventing cold winter winds

Considering the climatic conditions of the region the priorities are quite obvious. For example preventing cold winter winds is important, but the more important is using sunlight especially during cold and frigid seasons. Although these regions are located in the steps and are windy and cold winds during winter have significant effect on development of cities in this region. Studies made into past architecture of Iran has shown that this decision was made to satisfy both needs but focusing on the more essential factor. Form, shape and direction of traditional residential houses in this region were also completely influenced by climatic conditions. Characteristics of urban structure in this region are:

- 1) The determining fact of sunlight direction and topography in continuation method and development of general urban and rural structure

- 2) Formation of alleys and main passages parallel to surface level and mostly narrow to reduce wind penetration and utilizing the heat leaking from the walls of the residential buildings to warm the alleys.
- 3) Concentrated urban structure and connected buildings.
- 4) Small and confined urban areas to prevent wind penetration and uncontrolled cold air.
- 5) Using introvert patterns and central yard.
- 6) Positioning the main section of the house northwards to utilize maximum sunlight and east-west coordination
- 7) Small balconies and yards (most activities were performed inside the house)
- 8) Reducing the ratio of exterior surface to the volume of the building
- 9) Using small doors and windows



Fig. 8 Hamedan in Cold and Mountainous Climate of West

D. Warm and Arid Climate of Central Plains of Iran

These plain which constitute a major area of Iran are located in the central and eastern regions. Warm and arid climate in summer and cold and arid in winter, very low precipitation and humidity, scarce vegetation, high difference between day and night temperature and warm winds along with dust are the characteristics of this region. While difficult conditions for living, the traditional Iranian architecture provide agreeable living comfort. The adaptation of urban structure and lifestyle with natural elements and also utilizing these elements in the unfavorable conditions of this region is considerable. It can even be said that one the greatest achievements of Iranian tradition architecture is adapting of proper living conditions to these arid and warm regions. Formation of urban structure in these regions is based on maximum utilization of favorable air flow, avoiding troublesome winds, providing maximum shade and minimum heat absorption. Considering coordination with sunlight direction is more important than coordinating with wind direction, also conservation of humidity to cool urban areas and buildings were among the most important objectives and therefore the urban structure of these areas follows these principles: [5].

- 1) Coordination and establishment according to wind and sunlight direction
- 2) Very concentrated structure
- 3) Completely confined urban areas
- 4) Narrow and irregular mazelike alleys often covered to reduce the effect of troublesome winds and also minimize

indirect reflection of sunlight and heat from the surface of streets and open spaces

The important characteristics of the residential buildings of this region for adapting to the climate are:

- 1) Introvert and central yard for shading and improving ventilation
- 2) Using north and south sides (in the northern hemisphere the angle of sun rays makes the south side absorb less heat during summer and the north side is warmer during winters and vice versa)
- 3) Lower level of the yards compared to passages
- 4) Compact forms and arrangement of buildings, low area to volume ration and creating layers of shades to reduce sunlight
- 5) Relatively equal heights of the buildings for uniform distribution of wind



Fig 9. Yazd in Warm and Arid Climate of Central Plains of Iran



Fig. 10 Central courtyard and pool in order to cool weather, Kashan, Iran

IV. CONCLUSION

As mentioned before the traditional architecture of Iran paid utmost attention to the comfort of residents when designing urban structures, passages, urban areas and residential buildings. Therefore considering the climatic conditions of each region and past experiences in adapting to the climatic conditions played a key role. While in the recent decades of Iranian architecture, passages and building coordination are made by factors such as efficient use of urban plots, using wide and direct streets, following limited regulations of municipalities which are mostly exterior surface of buildings towards the passages and streets.

This issue has created numerous troubles in urban areas and residential buildings. Warm and irritating summers disrupt outdoor activities and life inside buildings, while cold winters with uncontrolled winds disrupts the comfort outside and inside buildings. These problems also increase the use of mechanical equipments and seasonal fuel consumption surges. The experiences of Iranian traditional architecture can provide effective guidelines to adopt designs conforming to climatic conditions. Of course a retrospective return to past architecture is not possible and the lifestyle of the past is not sufficient for today needs. But extensive studies in this field as carried out in other countries seems to be necessary. Learning from traditional architecture does not mean imitating old patterns, but their logic must be gleaned and adapted. The objective of these studies must be reutilization of climatic factors and establishing the lost connection between human and nature so that modern technology is used only when climatic measures cannot provide comfort requirements.

REFERENCES

- [1] Ghobadian.V, "Climate Analysis of the Traditional Iranian Buildings, 5th ed", Tehran: University of Tehran Press, 2008.
- [2] Koch-Nielsen.H, "Stay Cool, A Design Guide for the Built Environment in Hot Climate, Sofalali.F, 1th ed", Tehran: Center for Architectural and urban studies and research, 2010, pp.63-77.
- [3] Evan.M, "Housing Climate and Comfort", London: Architectural Press, 1980.
- [4] Givoni,B, "Passive and Low Energy Cooling of Buildings", New York: John Wiley and Sons Inc, 1994.
- [5] Tavassoli .M, "Build City and architecture in Arid Climate", Tehran: University of Tehran Press, 2003, pp 68-70.