

The Study of the Form of the Building in Climates of Iran

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Abstract: Ancient civilization of Iran was always important by its historical buildings; the cities with historical texture with native materials based on intelligent thinking of Iranian Architecture and construction of buildings according to climatic conditions were done to provide a place for human being comfort. While without imposing any extra cost, it had considerable share in optimization of fossil fuels consumption and used natural energy by passive and traditional method. Iran by 4 different climates uses passive methods in accordance with the special climatic condition of that region to design housing by traditional methods and its study is the main aim of this paper. At first, a general introduction of climate is introduced then, the characteristics of native architecture in the region is reviewed and then the design regulations such as building direction, the shape and construction of the building, open and close spaces characteristics etc are dealt and finally the important points in native architectural designs in accordance with climate are concluded.

Key words: Climate • Caspian beaches • Mountainous • Plains and deserts • Beaches • Oman and Persian Gulf islands • The study of climate native characteristics • Design regulations and form of the building • Establishing building spaces

INTRODUCTION

Human being has always attempted to use the surrounding environment for his/her comfort, so he enjoys with 4 natural elements in the nature including wind, water, soil and fire by his intelligent thought. Iran is one of the countries with a lot of experiences about using natural energy by passive method that is observed in native architecture of different regions of Iran and created some buildings compatible with climatic conditions. Using these methods in construction of today life spaces can plan an important role in optimizing fossil fuels consumption without imposing any extra expenses. This can be the main problem of this paper.

At first, the characteristics of 4 climates are introduced then, housing design regulations such as direction, manner of establishment and form of the building, Open space, semi-open and close space performances are reviewed and finally each climate are classified in the conclusion. It is expected that the current paper is good for sustenance of development idea based on permanent design principles for designers and researchers.

The Introduction of Four Climatic Characteristics

Caspian Beaches (Climate Group 1): From the comfort of human being, this climate has rather hot summers and rather cold winters and the problem of these regions is the high humidity and in the followings we review and present the plans in accordance with this climate and functional design.

Mountains-High Foothills (Climate Group 2): In these regions due to cold and dry climate, the weather is good in summer and it is cold in winter and the main problem is in cold conditions.

Semi-high Foothills, Plains and Deserts (Climate Group 3): This climate in hot weather is rather hot and dry and it has cold winter. In these regions protection against cold weather of winter is more important than hot weather of summer.

Beaches, Oman and Persian Gulf Islands (Climate Group 4): In this climate the summers are very hot and humid and it is mild in winter. In these regions preventing severe heat and high humidity is of great important [1-4].

Reviewing the Native Architecture Characteristics of 4 Climates

Native Architecture Characteristics of Caspian Beaches:

Buildings of this region are single due to high humidity and soil and air is circulated around the building to guide good winds to inside the house.

In spite of the high humidity, buildings soil is normally located on the platform or pilot and mostly they don't have basement and the rooms are connecting with the open space from two fronts. In other words, the building is surrounded by yard and open space and there are various openings in the body of the building except in the fronts facing to the dominant wind, openings are not installed.

In some of regions of this climate, the buildings are two-storey and the second floor due to better use of draught is mostly used in summer and the first floor with less draught and less open space is mostly dedicated to the winter condition. The ceiling of these houses are mostly steep to plan an important role in using semi-open space when a great area is considered and at good climate condition, people mostly live in porch (Ivan).

In Caspian regions mostly west and North West fronts of the building exposed to the cold wind blow of the winter are considered as a barrier against west dominant winds by ever-green tall trees [1-3,5].

Native Architecture Characteristics of Mountainous Regions:

In mountainous regions most of the time, cold weather should be avoided, so heat exchange should be at minimum by the walls in the building and sun radiation should be used at most. In these region due to high slope of the ground, the buildings are compacted and are mostly multi-storey buildings and some parts of the building is located under the ground considering the slope of the mountain, thus, the contact surface of building walls with open air is reduced to the minimum level and in foothill areas with low slope, the building is compact with the minimum level of the yard and opening in the building wall.

The houses are mostly built as central yard but the rooms on the north side of the yard are receiving sun and they are bigger and they are dedicated to hall and the main living room. In most of the cities in these regions the bottom of the yard and the rooms are about 1 to 1.5 m lower than allay in order that running water enters the flowerbed better and on the other hand, it surrounds the house as an insulator to decrease the heat between inside and outside of the house.

The roof of the buildings is normally flat or steep. Flat roof due to the aggregation of snow on the roof is acting as an insulator and avoids heat exchange by the roof.

The rooms don't open to the open space but a mediator space is opened to avoid cold air to the building as they are opened or closed. Also, the rooms' height is low to heat the room and consume less fuel. But due to using materials with high heat capacity, heat is less wasted inside the building.

Internal and external walls are very thick made of heavy materials such as stone, brick and adobe to store much heat. The windows are small in this climate and are protected mostly by wooden doors from outside and the direction of windows in sunny fronts is of great importance to use sun during the day. It is worth to mention that dark colors are used as a solution to attract more sunlight in these regions [2,3,5].

Native Architecture Characteristics of Plain and Desert Areas:

In plain and desert areas, avoiding cold weather of winter in $\frac{1}{4}$ of the year and reduction of dry heat of summer in half of the year are of great importance thus, heat exchange is controlled by the walls in the building and sun radiation is used at most in cold weather and cool circulation of breeze in hot conditions. In addition in summer, 2 or 3 months at noon, the heat is unbearable and evaporative cooler is not adequate alone. The winds in arid areas are very problematic as in summer there are dusts of strong winds all around and in winter it is freezing.

Native architecture of these regions are at best compatibility with climatic conditions due to high heat in summer, humid and cool basements are common in most regions of this climate. In some cases the basement is consisting of a vent to the yard side and the air of the yard is cooled in this way.

Sometimes some vents are installed in the ceiling for air circulation in the house and hot air of the room or kitchen collecting under the arch ceiling are guided to the outside. In some cases by considering environmental conditions, wind catcher is used. Wind catcher is mostly located in north side front and summer rooms. When the basement is located under this section, one head of wind catcher is leading into the basement and cool air of the basement enters the yard and then it is guided to the hot rooms of the house. To make the house cool in summer, evaporative cooler water is used in some spaces called Hozkhane. This place has tall ceiling and a pond and fountain is located at the middle of it and some vents in

the ceilings and networks in the walls of the body of *Hozkhane* facilitates the air circulation. Sometimes the head of wind catcher opens directly to *Hozkhane* and when air passes from the fountain, the wind is cooled and is sent to other spaces of the house including the yard.

When the yard is divided into inside and outside sections, sometimes *PANJ DARI* room, the door between two yards is located as two sides and if it is open to its doors from both sides-due to dry air and temperature difference between shade and sun, cool breeze flows from shady front to sunny front and makes the rooms and yard cool. To reduce sun radiation in these regions, sashed windows with meshed color glasses are used. Thus, the space behind these windows in cold condition besides using sun heat is protected against ultraviolet radiations. In hot conditions by opening these windows the building will have semi-open and cool space facing to the yard. Sometimes to provide more cool air and shade, the yard is inside the ground, these yards that are used in combination with the main yard are called *Godal Baqche*. Besides the main yard there are some small yards used as *Narenjestan* creating a cozy and comfortable space for other activities. Also, in these regions the summer heat is not bearable. Some deep *SARDABs* are built and they are connected to Qanat by some channels (if possible) to enjoy the natural cool air, humid air of the basement and Qanat duct [1,2,4,6].

Native Architecture Characteristics of Oman and Persian Gulf Beaches: In these regions protection against heat, high air humidity and soil are of great importance so, establishing permanent air flow inside and outside of the buildings and creating shade are of architectural necessities of these regions. The density of the buildings provides air circulation around them due to high air humidity and less soil and single buildings.

Native architecture of this region is consisting of some buildings with central yard but in most of the cases the ground floor is dedicated to the service space and living spaces is transferred to second and third floors having better wind and draught. Using wind catchers facing the beach is common for using the sea wind in some of the zones of this climate such as Lenge port.

The walls are high to place more air inside. On one hand due to high air volume they don't get hot and on the other hand, hot air goes to the ceiling and is ventilated via small windows on the ceiling or above the wall. The windows and openings are small for better draught in the rooms, some holes are considered at the top and bottom

of them to enter the minimum heat inside and cool the room beside the ground level. In some cases the openings are big and instead its body is covered by wooden or brick network and besides creating shade, draught is created. There are big and deep Ivans with high height in front of the rooms to be used in most of the year when the weather is hot. The ceilings of the houses are normally flat and they are used for night activities and sleeping. Due to this fact the roof is having high latticed parapet that besides proving necessary privacy, doesn't prevent air draught. The deep Ivans in front of the rooms and latticed parapets on the roof provide good shade for yard and the walls [1,2,7].

The Analysis of Design Regulations of Climates Building Direction

Direction of the Building in Caspian Beaches: Good direction of the building is of great importance. The best main front in the building in these regions for sun radiation is the direction in which in hot condition there is less hot and in cold condition, the most heat is received and also in two third of the year draught is required. On the other hand, in cold condition, it is protected against north and North West wind blowing. The best direction in this region for sun radiation in a building with one open front is south to southeast with 30 degree skew from the south and in a building with two open fronts opposite to each other northern-southern [5]. North faced front and the fronts near to this amount are the best front in hot weather and it can be dedicated to the spaces used mostly in these days.

Building Direction in Mountainous Regions: The best main front in the building in these regions for sun radiation is the direction in which in hot condition there is less hot and in cold condition, the most heat is received. The buildings with one open front from the aspect of sun radiation are south east with 15 to 45 degree skew from the south. The best direction for the establishment of the building with two opposite open fronts is northern-southern to north west-southeast with the skew of 30 degree from northern southern axle [4].

The Direction of Building in Desert Areas: In these regions the best main front in the building in these regions for sun radiation is the direction in which in hot condition there is less hot and in cold condition, the most heat is received and unsuitable winds of cold seasons are avoided and good winds are used in hot seasons.

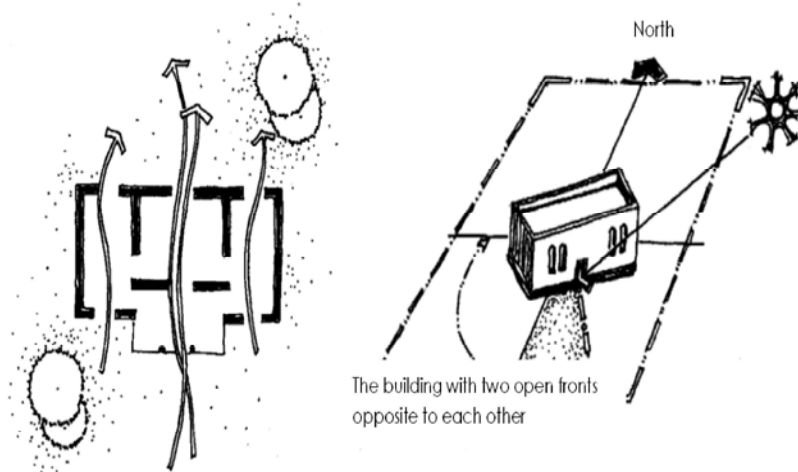


Image 1-1: The establishment of interior spaces to use air draught, sun radiation [8].

If the direction of good winds is not consistent with good direction from the aspect of receiving solar energy, they architectural strategies such as wind catcher should be used. The best direction in this region for sun radiation for a building with one open front is southeast with 15 degree skew from the south and for the building with two open fronts opposite to each other, south north to northwest southeast with maximum 30 degree skew from the south.

Building Direction in Southern Beaches of Oman and Persian Gulf: The most important direction for the establishment of the main front in the building for sun radiation is the direction in which the minimum heat is received in hot weather and the maximum heat is gotten in cold weather.

If the direction of good wind is consistent with the direction, by opening the windows of this front, it can be used. But if the wind direction is not consistent with the said direction, the architecture strategies such as wind catcher should be used. The best direction for sun radiation for the establishment of the building with one open front in this region is south to southeast with 30 degree skew from the south and for the building with two open fronts opposite to each other, is north-south and it is consistent with dominant winds in most areas of this region [2,4].

Form of the Building

Form of the Building in Caspian Beaches: From the importance of creating draught aspect, every close space should consist of a vent for air inflow in the pressure zone

and a vent for air exit in wind suction zone. The best case is that these two vents are located on two walls opposite each other. In case of design limitation, two adjacent walls or one wall along with some solutions to create pressure and suction are used.

Thus, it is better that any close space is connected with open air from two fronts and it necessitates one layer nature of the building. Thus the buildings should be placed as linear beside each other, it means that the building should be in the form of thing rectangle stripes built around or at the middle of the main yard. These rectangles can be put on each other because they occupy less space and on the other hand air flow is better used by increasing height [1,2,5].

The Form of the Building in Mountainous Regions: The importance of decreasing heath exchange in cold weather buildings led into the selection of some shapes as sphere, hemisphere and square cubic in the construction of the building because due to their low external surface in comparison with the required volume, heat is wasted less but the existing problems in building and furniture with circle plan has restricted this kind of circle plan. So, it is better to use the volume of square cubic with the height of the half of square angle. On the other hand, lowering the walls surface related to open air, heat exchange is reduced. For this aim, construction of compact buildings adjacent to each other is necessary in the surface and the height. Also, there shouldn't be any dip in the fronts faced to the west and east and the directions near to it or the fronts faced to the winds due to the creation of coldness trap [1].

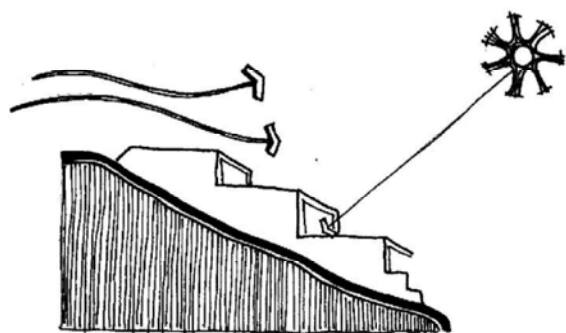


Image 2-1: The establishment of the building on the slope [4]

Form of the Building in Desert Areas: In this climate due to the importance of heat exchange reduction from the external walls of the building, the surface of these walls should be at minimum. This is possible by two ways: First, by selecting volumes with low lateral surface and equal volume and equal infrastructure, second, by connecting lateral surfaces of the building to the adjacent buildings to reduce the walls exposed to open air. Thus, at first the spaces with circle plan and convergent ceiling and then the spaces with the shape of square with the height half of the square angles are recommended [1].

The Shape of the Building in Oman and Persian Gulf Beaches: From the importance of creating draught aspect, every close space should consist of a vent for air inflow in the pressure zone and a vent for air exit in wind suction zone. The best case is that these two vents are located on two walls opposite to each other. Thus, it is better that any space is connected with open air from two fronts and it necessitates one layer nature of the building. Thus the buildings should be placed as linear beside each other, it means that the building should be in the form of thin rectangle stripes built around or at the middle of the main yard. These rectangles can be put on each other because they occupy less space and on the other hand draught is better used by increasing height [8].

The Method of Establishment of the Building in Climates
The Method of Establishment of the Building in Caspian Beaches: High level of underground water in coastal areas, humidity of the soil in the region and the importance of creating draught cause the fact that the building should be far from the ground because the buildings being higher than the ground level use wind flow better and they are damaged less by the humidity of the ground.

In addition, the construction of the spaces without wall can help the wind flow under the bottom of the building as a pilot in the ground floor. In the areas farther from the beach such as foothill regions with less soil humidity and steep ground, the building can be located directly on the ground or designed as stair shape [1,2,5].

The Establishment of the Building in Mountainous Regions: The construction of the main part of the building on the basement or *Gorbero* reduces thermal conductivity from the building to the ground on condition that there is insulation around it. Basement space in hot seasons is cooler and hotter in cold season from upper space and basement can be used as service space. Thus, the construction of multi-storey buildings with limited plan surface is more suitable than big one-storey building. In this case the facades faced to cold winds are protected by wind breaker. Using south and southeast faced slopes are good for the construction of the building on condition that northern and northwestern cold fronts are reduced at minimum and using stair buildings are suitable in these slopes [1].

The Establishment of Building in Desert Areas: This climate due to the importance of reduction of thermal exchange from the external walls of the building, the surface of the walls should be reduced at minimum or they can be placed inside the ground. Because temperature changes inside the ground are much less and slower than ground surface. On the other hand, to use ground cooling property or cooling guide the building should be connected to the ground [1].

Establishment of Building in Persian Gulf Areas: Due to high underground water level and the importance of creating draught is important. The construction of the main spaces of the living is higher than ground level because the buildings that are higher have more wind blow and less humidity. The construction of the spaces without wall and pilot at ground level can help the air flow [5].

The Study of Open, Semi-open and Close Spaces
Open, Semi-open and Close Spaces in Caspian Beaches: The spaces of these regions should be built in a way to use wind in hot seasons, so the distance of the building from the walls and the buildings in the northeast and south shouldn't be less than 4 times the heights. Considering this fact that the most amount of wind in hot conditions is blowing from northeast, north and

northwest in this climate, the best shape of the yard for receiving sun radiations is rectangular shape with its large angle to the south to southeast with 30 degree skew from the south and the best shape for the ground is rectangle with its large angle in northern-southern direction [2,4]. Due to high rainfall, the roofs should have good slope with adequate drainage. Indeed, the roofs slopes are constructed faced to the west, because the rains are discharged better in this way and by making the slopes longer, the rain cannot penetrate to the western façade of the building [1].

Semi-open spaces in these areas are common and these spaces facilitate air flow at the same time protection against rainfall and sun radiation. Building semi-open spaces beside or around the close space is very useful. The long angle and close space faced to the north and south provide uniform radiation in the surface of these spaces and more openings and better draughts are provided. Due to high humidity of the region, the spaces should have tall ceiling to provide more air and avoid temperature and humidity increase in close space. As it was said, the best front for the establishment of the main space of the building is the fronts faced to the south and southeast. These spaces should have some openings to the open space from two sides to enjoy the natural draught and air entry and exit should be designed as large [1-3].

Open, Semi-open and Close Spaces in Mountainous Areas: In mountainous areas sun radiation should be used at most, so southern wall of the yard should be low or the distance of the building from the buildings located in its south direction should be more than double size of the heights. To avoid cold wind, it is better that eastern and western walls of the yare are tall and its width is less than 4 times the height of the above wall or they are protected by the adjacent buildings or wind breaker, so the yard is built in the shape of square or rectangle with its longitudinal axle to the northern-southern direction. In this climate due to freezing and rainfall, flat or steep roof is good and in one-way steep ceilings, the best slope is faced to the south and the ceiling with two way slope is best for east and west slopes. To make the effect of winter wind at minimum one of the followings methods are recommended:

- Reduction of surfaces exposed to wind
- Putting some parts of the building into the ground
- Using totally flat façade
- Reducing the height of entire building

In this climate semi-open spaces are not very important. The construction of semi-open space in front of the room is only to avoid direct contact of open space with the space inside the building. As the establishment of the main space of the building is the southeast faced front with about 15 to 45 degree skew from the south. These spaces should be close from other directions and restricted to the adjacent buildings. Placing the short angle and close space to the open space reduces thermal wastage from that front. Also, building room with small dimension from one side of the short ceiling cause energy saving [2, 3].

Open, Semi-open and Close Spaces in Desert Areas: The building in these areas should use direct radiation of sun during cold season. So, its distance from the walls and the buildings located in its south direction shouldn't be less than double size of their height in the northern widths and its equal in southern widths. Thus, the best shape for the yard is rectangular shape with its long angle in the south-north direction.

Increasing the height of other walls to avoid cold winds and sun radiation during hot weather to the yard is good. In this climate due to less humidity of air, water level and plants have important role in reducing temperature and making the air cool by evaporative cooler water. Also, the limited rainfall made the construction of flat roof [1].

In this region due to special climatic condition, semi-open spaces are common because air flow is provided at the same time with sun contact. Semi-open spaces in this climate are constructed by two ways:

- Independent, called as *Ivan* and *Qorfe*
- Pre-space, it connects open spaces to close spaces

The best establishment of close spaces and the fronts to the south and southeast for four season's spaces is northern front for summer spaces. To reduce thermal exchange, the small angle of the room is faced with the open space with small window and summer spaces as close space are consisting of tall ceiling to make them cool [8]. Open walls in this region during hot season are located in the shade and are located in the sun during cold season. Thus, in this climate the windows should be placed to the south and southeast with horizontal shade and northern front window should have vertical shade beside the window [5]. If the windows are not adequate in these buildings, ceiling vents can be used in the upper section of the wall. In these conditions, using vertical

channel such as wind catcher, chimney etc are good for ventilation [1].

Open, Semi-open and Close Spaces in Persian Gulf Beaches: In these regions northern and southern wind should be used. So, the distance of the house from the buildings located in the north and south shouldn't be less than 4 times of their height. Thus, the yards should be in the shape of rectangle as its longitudinal axle is in the north and south direction. By suitable use of draught and one-layer nature of the building, it is better to locate the yard in both north and south sides of the main space of the building. Unless that front is linking to the alley or other open spaces. In this climate due to high humidity, water and plants done have important role in cooling air by evaporative cooling. The roofs in these regions are flat or steep with suitable drainage and latticed parapets are used to pass air. In this climate semi-open spaces are more common and are used in most of the seasons. The shade in these buildings reduces the temperature of the walls. These spaces are divided into two main groups in terms of shape and location:

The first group is the semi-open spaces located in front of the close space and besides having different functions, protect the close space behind them against direct sun radiation.

The second groups are separated spaces located in the proximity of other spaces. In the close spaces, the main space of the building located in the south and southeast fronts are good for four seasons' spaces and north fronts for summer space. Close spaces should have some openings to the open space from two sides to enjoy natural draught. So, placing the long angle of the close spaces to the north and south cause to receive uniform light and on the other hand more openings and better draught are provided.

In open walls, they should be located from one side in the shade and from the others exposed to air flow. Thus, these openings besides being large should have extensive shades [1-3,4,8].

In this Climate:

- The south and southeast windows should have horizontal latticed shade
- Northern front windows with vertical latticed shade beside the window
- If necessary, windows of east and west should have vertical and horizontal shade in front of the window and also they should be equipped with mobile vertical shade.

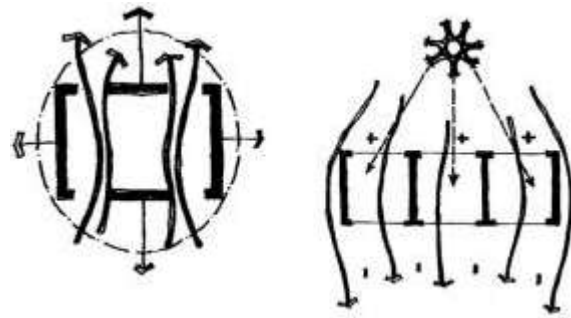


Image 4-1: Using natural draught [4]

If the windows are not adequate, ceiling vents or short wind catchers in these regions are good for ventilation [1].

CONCLUSION

(Conclusion of Important Points in the Building Design)

Caspian Beaches:

- Texture of building set is unconcentrated and dispersed in both villages and city
- In the regions beside the sea, to protect against high humidity of the ground, the houses are constructed on wooden or pilot pedestals.
- To protect the rooms against rain, wide and close Ivans are created around the rooms and the roofs are built as one or two- way steep.
- The materials in most of the buildings have low thermal capacity.
- Generally to create draught and air ventilation, the building is in the shape of elongated northern and southern with extensive and open plan.
- The windows are in rectangular shape and to use more light and heat are directed to the good wind from the sea side.
- The directions of the houses are east-west to create good ventilation and draught.
- The best front for the direction of the building is south to southeast with 30 degree skew from the south and the building is having two open northern and southern fronts.
- The spaces of the house should be in a way that openings are located opposite to each

Mountainous regions:

- Plan of the buildings of these regions are compact
- The minimum window and opening is installed to avoid draught and cold internal space

- Using the materials with high thermal capacity and good thermal insulation. Usually, in mountainous areas stone is very common.
- By flat volumes to keep snow, it is used as a good thermal insulation.
- Placing the houses in the slopes to the south for use more light and heat.
- The volume and form of the house should be Compact Square to avoid heat wastage.
- In these regions the windows are vertical and small in order that the light reaches the depth of the rooms.
- These windows are mostly located in the southern section and are protected from outside by wooden doors and there are few windows.
- The best direction of the building is 15-45 degree skew from the south and the form of the building is square cubic to reduce thermal exchange.
- Openings and windows of the building should be as two vents opposite to each other to provide ventilation.
- For better use of south and north wind, the yards are in the shape of elongated rectangle and its longitudinal axle is in the northern and southern direction and in two yards in the south and north.
- The establishment of the building due to avoiding humidity and draught creation is one pilot and floors pedestals. are used in this climate.
- The ceiling of the houses is flat with good slope and latticed parapet to create shade and cool air in the roof to provide cool air and draught.

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Desert and Plains Regions:

- In this region and climate due to hot and dry weather, the texture is compact.
- To reduce sun radiation, sashed windows with latticed color glasses and shades are used.
- The buildings have mostly central yard and spaces around them.
- Using domed covers and adobe ceiling to have shade in the roof and thermal insulation.
- The presence of Godal Baqche and foundation to make the yard and rooms cool.
- The presence of tall wind catchers in 4 sides to use cooling system and ventilation of the house especially the rooms for summer in hot season and most of the seasons.
- The presence of basement and a space called Hozkhane and wind catcher in the northern front and summer rooms are of great importance.
- Ivan is of great importance in these regions.

Oman and Persian Gulf beaches:

- The direction of building in these regions is southeast with 30 degree skew from the south with two open fronts opposite to each other, south-north direction.
- The main spaces of the building to use light and energy are good in the front to the south and in hot season in the north front.

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