

The effect of climate factors:

The logic of form, architecture and city texture according to the climate

The major problems for people living in hot arid climate:

- 1.Scorching sun
- 2.High temperature during day time and low during night (fluctuating temperature)
- 3.Dry weather and little rainfall
- 4.Sand storms

SOLUTIONS:

- 1.Reducing the contact with the heat and the sun
- 2.Creating shadow wherever possible
- 3.Minimizing the façade which is towards the sun
- 4.Making small openings

All these solutions have resulted in creating compact and closed cities

PASSAGEWAY:

Narrow vaulted roof and shaded streets crossed by buttresses, which are cool in summer. While designing cities or any residential complexes in this climate it's necessary to consider the direction of the desirable winds since by locating the passageway in the same direction of these winds you can bring the cool air inside the city.

FAÇADE:

It is better to make the façade uneven and transposed in this way the surface would not get the sun completely and some places would have shadow.

ROOF, DOME, VAULT:

In the hot arid area the amount of sun radiation over the roof is the highest comparing to other part of the building therefore reducing the outer surface that gets sun should be considered. Predicting any kind of barriers or prominence that produces shadow over the roof is one of these solutions.

Parapets should be designed higher than usual in order to hold the cold high winds and to create more shadows for the alleys.

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In geometry the widespread of a dome is three times its base area therefore the severity of the sun over it's round body is reduced and the temperature of the bottom part of the dome is reduced as well.

Two-layered Dome has two layers therefore the air between these two layers functions as insulation and the inner layer is always cooler than the outer one. Because of these two layers both the space underneath the inner layer and the building from outside look more proportional in the eyes of the visitor.

WINDCATCHER:

A climatologically responsive element interconnected with several other main elements including Talar, Panjdari, Zirzamin, also a distinguished symbolic element of the towns and cities in the hot arid zone.

Three-sided wind catcher: in this type of wind catcher the surface which is catching the wind is bigger and with more holes and the other two sides will also catch the wind if the desired wind would change the direction. When the wind reaches the holes because of their curved shape it would easily be drawn downwards. The velocity of wind in the entrance is greater than its normal velocity. dividing the opening of the wind catcher not only increases its resistant against wind but also increase the velocity of the wind when it's flowing down.

One-sided wind catcher: if the desired wind is only from one side then we have one-sided wind catcher.

Since the direction of the desired winds and non-desired ones are mostly opposite of each other when stormy winds are blowing at the back of the wind catcher, these wind catchers will suck out the air inside the room.

In some part of the desert it is also possible to cool the house with out using wind catchers. In this way that they would put an air duct on top of a four-vaulted room that would suck out the air inside the rooms so that the fresh air of the garden would flow inside.

GARDEN AND IVAN:

The summer areas of the house including Ivan and Talar look to the northeast to avoid the heat of the afternoon sun.

Ivan is the semi open area in the summer part of the house that is located over the cellar. The floor of Ivan is usually located a few steps higher than the garden. This difference between the garden and Ivan is used for the ventilator of the cellar that is usually located under the summer part. In this way the cool air inside the garden will flow down to the cellar and later will be sucked up by air ducts.

Garden: because of the tall walls from each side the garden is usually very deep and in hot days of summer it will full of shadow. During night when the weather is cold the cool air that is heavier than the warm air would stay at the bottom of the garden and during daytime the garden would be the coolest part of the house and the difference between the temperature of outside and inside the garden is tremendous.

the PIGEON HOUSE or KABUTAR-KHANEH in persian was usually build in areas with desert climate but in a way to benefit from the construction materials and methods influenced by environmental conditions. due to the architectural tissue of clay, straw and salt made their combination resistant to heat and cold which can also function as heat and sound insulation for pigeons. to maximize the utilization of space these buildings were shaped like cylinders. the entrance was designed in a shape and size to welcome only the pigeons and not other visitors and the mud body was to prevent the vermin birth. for more strength the interior was armed with cross wooden joists and the exterior was coated with a special kind of mortar called sarooj to prevent environmental degradation. in the hollow middle part above the pigeon house some openings were designed for heat exchange and flow of air which have much affinity with the wind catchers of desert. in these buildings usually a well was dug in order to provide the water needed for the pigeons in cases where there were not any lake available. the simultaneous flight of about 14 thousand to 25 thousand pigeons and the strong vibrations caused by it, lead to the applying of physics principles such as resonance in these buildings.

WIND MILLS

many local and foreign researchers have claimed that Iranians were the first nation to use the propulsion of wind and took advantage of it in grinding and wheel wells. the first windmills were built in the region of Sistan in south east of Iran around 10 centuries ago and historians believe that it went from iran through afghanistan, india and china to france , spain and portugal and only the constructing method changed but the principles stayed the same.

at first they would construct tall towers like minarets. the building of wind mills is composed of two parts: in the lower part the grinding stone are placed and in the upper part the wheel that will turn with the wind is located. then four slots is made in the wall which will get smaller on the inner side and through which the wind will pass with a very high velocity.

super adobe

Superadobe (sandbag and barbed wire) technology is a large, long adobe. It is a simple adobe, an instant and flexible line generator. It uses the materials of war for

peaceful ends, integrating traditional earth architecture with contemporary global safety requirements. Long or short sandbags are filled with on-site earth and arranged in layers or long coils (compression) with strands of barbed wire placed between them to act as both mortar and reinforcement (tension). Stabilizers such as cement, lime, or asphalt emulsion may be added.

This concept was originally presented by architect Nader Khalili to NASA for building habitats on the moon and Mars, as “Velcro-adobe”.

The structural principles of the timeless forms of arches, domes, vaults, and apses are built with the materials of earth, sandbags and barbed wire using the engineering of single and double curvature compression shell structures, to reach the ultimate in strength, self-help, and aesthetics. In Superadobe, the ancient earth architecture of the Middle East using sun-dried mud bricks is fused with its portable nomadic culture of fabrics and tensile elements, not just through design and pattern, but through the structure itself. Structural design uses modern engineering concepts like base-isolation and post-tensioning. The innovation of barbed wire adds the tensile element to the traditional earthen structures, creating earthquake resistance despite the earth’s low shear strength. The aerodynamic forms resist hurricanes. The innovation of sandbags adds flood resistance, and easy construction, while the earth itself provides insulation and fire-proofing.

The Superadobe can be coiled into vaults and domes, the way a potter coils a pot, with barbed wire reinforcement, to build structures which pass California’s earthquake codes. These structures can last for one season before returning to earth, or they can be stabilized, waterproofed, and finished as permanent houses. The system can be used for structural arches, domes and vaults, or conventional rectilinear shapes. The same method can build silos, clinics, schools, landscaping elements, or infrastructure like dams, cisterns, roads, bridges, and for stabilizing shorelines and watercourses.

Materials research on the bags has shown that the majority of existing bags of both natural and synthetic material can be used. Natural woven jute bags have not been used by the architect because of toxic chemical preservatives like formaldehyde; instead, a synthetic, low UV (ultra-violet) resistant degradable material has been preferred. The bags or long tubes are used primarily as temporary flexible forms. In a temporary building, the bags are allowed to degrade and the building returns to earth. For permanent structures, the synthetic bags are plastered over to provide an erosion resisting layer, or they can be removed when the stabilized earthen filler is cured. The barbed wire is four-point, two strand, galvanized barbed wire and is recyclable. The earthen materials of clay and sand, with straw and water which have been used to make traditional sun-dried mud-bricks for millennia are not always available, nor do those most in need of a home have the time to make blocks, dry them and store them. By filling bags directly from the land and reinforcing with barbed wire, almost any earth can be used and the speed of building is much faster yet still in the hands of people.

Safety Standards and Comfort. Cal-Earth's sandbag structures, reinforced with barbed wire, have successfully passed tests for California's high seismic building codes, making them resistant to earthquakes as well as fire, flood, and hurricanes. Their design and thermal mass create comfortable living spaces based on the time-tested, sustainable architecture of harsh environments, such as that in the architect's native Iran.

YAKH-CHAL is a pit for storing the ice just as AAB-ANBAR was used for storing water. ice was produced in midwinter and during the cold months and later on this ice was used during the hot season.

applying all the climatic factors to produce the needed heat or coolness is among the basic principles of traditional architecture.

the structure of YAKH-CHALs were usually consisted of these elements:

1-water basin where the thin layer of water coming from Qanat would freeze over the night

2-wall that would surround the water basin to create shadow over it

3-ice pit where the crushed ice would be stored till the end of process

4-dome structure which was built over the ice pit to keep it cool

a deep pit is dug in the courtyard facing north and make a few ponds in front of it with 40 to 50 cm depth. during the night they fill the ponds with water and by the daytime when the water would be frozen then they crash it into small pieces. later they place all the crushed ice in the pit and refill the ponds with fresh water. after approximately 7 to 8 days a layer of ice with 1m to 2 m will be produced.

PARADISE

the persian word Pardis (or the word Paradise which was driven from its persian version) are actually coming from the word Paradaeza which has been used twice in Avesta (the holy book of persian prophet Zoroaster) combined from the words Pairi meaning periphery and Daeza meaning drawing a wall. these two words combined together usually meant gardening the surrounding. since the Achaemenian period and after them persian gardens were existing all over the country. in that era these gardens could not be found in other countries such as Greece, the people of those countries were affected by these earthly heavens and called them Paradise.

Boostan

which is another name for garden is consisted of two persian words Boo meaning Aroma and Stan meaning the house and place of something so together these two words meant the house of aromas referring to persian gardens where a variety of flowers and aromas could be found.

the antiquity of persian gardens dates back to 8-9 thousand years ago. it can be said that they are as old as the Elamites civilization and that Persian gardens were the first earthly gardens.

the main axis of the garden is mostly drawn from southwest to northeast to prevent the sun shining directly on it in the hot summer days.

the natural slope of the ground is used for creating the best view.

the ever flowing water in shaded side of the garden would help to create difference in temperature and therefore reducing the total temperature of the garden.

the main axis on a rectangular area with high trees and the cool flow of air would lead the guests to the pavilion which was located at the highest part of the garden.

persian garden plan is based on particular application of Square in its components and overall composition.

with the existing view elongated on the main axis of the garden in front of the pavilion and high trees on both sides of the axis, the perspective of the garden seems longer than the original.

the natural slope of the site makes it more suitable for the pavilion to be placed at the high point of the garden.

due to the sight error looking at a higher point than where one would be standing gives the illusion that the point is closer than the actual distance therefore looking at the pavilion from the entrance makes it look closer than it actually is, on the other hand from the pavilion the distance to the entrance of the garden seems further and the garden looks larger.

the main features of persian garden:

- 1.constructing garden in a steep land
- 2.the garden being surrounded by a wall
- 3.dividing the garden in four sections
- 4.using straight lines in designing the garden
- 5.the pavilion usually being in the center or at the highest part of the garden
- 6.using a main water channel running with water in every season
- 7.make the water flow in a way that it would make sounds
- 8.using a kind of carved stone (sineh kabki) that would make waves when the water is flowing
- 9.the close relationship between the pavilion,garden and the nature.

10. existing of a pool of water usually at the center of the garden, providing the necessary water and a magnificent view in front of the pavilion

11. using long trees with shades and narrow passages

12. assigning most of the garden for planting the fruit trees

13. planting different types of ornamental and medicinal flowers

14. planting Roses more than other flowers

Garden types:

1. fruit garden

the most simplest one but the most useful

2. habitat garden

many of the governors would built their houses inside a garden in which the size and grandeur of the garden was equivalent to the position of its owner

3. state garden

these were mostly fortifications in the city and since they had big gardens within them they could be considered as state gardens

4. state-habitat garden

in small cities where the governmental buildings were less than the others usually the house of the governors were included a space dedicated to state matters

5. riversides garden

many cities of Iran were located close to rivers and usually in these cities many garden was created by the riversides

6. tomb garden

gardens that were created around the tomb of wealthy or important people

different types of spaces in gardens

Sardar or Biruni (the head mansion):

the mansion that is built at the entrance and the part of the house for guards and gardeners. in state gardens this part was the place for all the state activities and in front of it there would always be a plaza or square for the ceremonial event.

Andaruni:

this was the most private part of the garden usually used for the family members and mostly consisted of a garden with Sour orange or Pomegranate.

Service areas:

this part was proportional to the grandeur of the garden and consisted of the storage area, bath house, water storage, tea house and the stable.

these places were never located on the main axis.

side and smaller spaces:

Baghche(small garden):

was a garden in smaller scales usually for flowers which was mostly seen in large gardens of wealthy people.

Godal Bghche(pit garden):

this type of garden were usually built in areas with less accessible water source. these were basically gardens that were lower than the ground level for better accessing the water and deeper for better creating the shadow. sometimes the depth of the garden would reach the depth of the Qanat.

The Geometry of Persian garden:

Persian gardens were either built on a plain land or on a steep land where it was easier to make the garden more beautiful with waterfalls and more trees. in persian garden great attention was paid to geometrical shape and among them Square which better shows the relation between different elements of garden has a special importance. another important principle about persian garden is the main view existing as a long drawn rectangle in front of the pavilion.

Geographic features of persian gardens:

1. low slope and flat gardens
2. hill garden
3. water garden
4. house garden
5. riverside garden

Plants in Persian garden:

people who have lived in Iran since ancient times were always familiar with many species of trees and plants and have a lasting bond with flowers and Noruz(The New Day, celebration of new year for Iranian at the beginning of spring) the celebration of trees and flowers indicates that.

in Zoroastrianism (the ancient religion of Iranian) the August Spenta (one of the six guardian angels which also bears one of the names of the God) was called Amordad meaning immortal and was the guardian angel of trees and plants.

from long time ago some trees were considered holy for Iranians and they believed with tying a piece of cloth to trees like Cypress, Pine, Oak and Walnut would make their dreams come true.

Trees:

for creating shadow in Persian gardens usually trees such as Willow, Buttonwood and Elm would be planted and to help to create more shadow the passage ways would be narrow so the shadow of the trees from both sides would fill the whole passage way. in clay land and salty soil that Sycamore tree can not be planted, trees like Poplar and Ash tree would be planted.

Bushes:

in this type of plants different types of Roses and Persian Jasmine are included.

Roses were always the most popular flower between Iranians and the name Golestan which is used for a place full of flowers is actually the plural form of the name Gol, the Persian name for Rose.

Roses and Cypress trees are two of the main components of Persian gardens.

Decorative flowers:

Persian Daisy

Persian Lilac

Persian Rose

Persian Violet

Persian Clove

Persian Wheat

Persian Syringa

Persian Apple

Persian Berry

Persian Dates

Persian Melon

Persian Orange

Persian Butterap

Persian Pomegranate

Water in Persian garden:

in Iran dry land water is scarce and valuable and looking at it especially in the morning and at the beginning of the month is auspices.

Iranians provide water with suffering, use it with providence and skillfully display it in gardens with more than it is.

the main water source in persian gardens is Qanat especially for gardens around deserts.

water enters the garden from one side, it circulates the whole garden, after irrigating all the plants and cooling the temperature of garden, it exits the garden and is directed to agricultural fields.

In Persian gardens since the water should appear more clear and cleaner than usual and also in hot summer days the water can easily be polluted with plants and Amoeba, the design should make the water circulate constantly especially when looking at a clean and clear water will induce coolness and joy to the viewers.

Pool:

pools are one of the main elements of Persian gardens which are overfilled with water and are built higher than the ground level.

pools are usually deep and consisted of few water jets.

Paradise streams:

Favareh or Shorn (Water jets):

water jets in Persian gardens are the elements that sprinkle the water with high pressure into the air and cool down the air.

to create water jets in gardens sometimes they would built a water tank higher than the ground level and using the pressure due to the difference in the height, the water would be sprinkled in the air.

Juy (Water channels):

to circulate the water through the garden and creating a better view of water, Juys are used which are water channels with the depth of 30 cm and width of 80 cm which would run through the whole garden and in specified distances they would have water jets.

Persian Garden and Persian Art:

creating gardens is one of the main themes of Persian art that in addition to various aspects of art such as architecture and decorative art has left a great impact on pottery,carvings,paintings, carpets,music and specially the vast area of persian poetry and literature to the extents that Iranians consider their country as " Sarzamin E Gol O Bolbol" meaning "the Land of Roses and Nightingales".