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A Survey in the Role of Climatic Elements in Forming Residential Buildings in Traditional Architecture of Dezful Town

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Abstract

It can be said one of the most important factors in designing the cities and houses is climate. The importance of the effect of climatic elements on architecture requires the comprehensive studies in this regard, namely in Iran with the variety of climate conditions as its effect is observed in the entire urban texture, even inside the buildings and internal architecture elements of spaces. Housing is one of the primary human needs and it is a factor to overcome the hard environmental conditions. Traditional architecture of Iran presented logical methods and solutions to provide the comfort of people. In this study, Dezful city was selected as a sample, based on . After the review of climatic elements, its recognition and definitions and definition of traditional houses architecture and appropriate architecture with climate, the effect of climate on construction of the houses in Dezful town and the solutions of architects of these buildings to design in accordance to the climate of the region are investigated. It is concluded traditional houses of Dezful are completely consistent with the climatic models of this region and are formed for them.

Keywords: Climate, Traditional houses, Dezful, Climatic elements, Architecture

Introduction

In thousands years of architecture of Iran, Iranians have attempted to create an environment beside their surrounding nature in which the consumer can provide the relative comfort for himself and his family based on the time of using positive points of the same location and nature. Due to high temperature and sun ray, he could not live above earth and he tried to come to basement and created a cool space by digging the land at the height 5 to 6m. Without any mechanical tool for damaging the environment, he turned the hot summer to cool spring. The difference of basement temperature with yard and the surrounding spaces reach 20 degrees sometimes and this means spring weather in a hot summer (Pirnia, 40, 2005-39). Due to the unduly increase of population, the need for more housing and increasing the land value, technology development and other social and economic factors justify more use of land cause that besides ignoring the local and traditional materials, the traditional plans consistent with the climate are also ignored and the residents should provide their relative comfort by cooling and heating. The new cooling and heating tools lead to more energy consumption and its cost is imposed on the society. On the other hand, these tools namely in winter lead to air pollution and pollution of these cities helps the coolness or heating of cities (Shaterian, 2008, 290).

The role of weather

The form of houses follows various factors and the natural factors are the most primary factors of housing formation. Appropriate heating and ventilation in interior space of building are also associated to architecture and it is not an easy work. This issue is regarding the comfort or non-comfort of people and heating or cooling concepts are mostly based on natural feeling of human being and his physiological conditions.

Climate and architecture

Climatology deals with Geographical condition of earth and the type of climate is created based on geographical division with its definite height of sea level. Generally, some factors as sun ray, the temperature of sun ray, air humidity and rainfall and various wind blowing are involved in climate issues and human life environment is affected and they are created based on these principles (climate identification) and architecture and construction of building.

The effect of climate on housing

As climate is associated with human comfort, it is the result of factors including sun ray, air temperature, air humidity, wind blowing. Some of them are explained briefly.

Sun ray: The light of each location is defined based on the angle and direction of ray. Also, it can be said urban and geographical factors should not create any problem in environment lighting.

Air temperature: The heat and coldness of earth is the main factor determining its high temperature. Air flow and wind lead to the more contact of great air flows with earth surface and it causes air heat. The sea level determines air temperature and in definite latitude, the regions in high height are cooler than lower regions.

Wind: The living place in terms of proximity to other buildings and geographical factors should be as movement and air ventilation are possible and its establishment should be as the effects of interfering winds are reduced and appropriate winds are increased. The maximum use of appropriate air flow is used for natural ventilation of house. If the living environment is exposed to severe winds, by green space, trees and bushes can be planted to reduce this problem.

Air humidity: Air humidity is the water in the form of vapor in air and this vapor enters the air via water evaporation of oceans and sea and humid surface as plants. The hotter the air, the higher the retention of water vapor. By reduction of height, water vapor height density is increased in air.

The order and building direction

As morphology or the texture of city is affected by other natural parameters, it is also affected by weather conditions. For example, a river or a lake except other items creates a specific and vital micro climate along the coast and this is the reason of longitudinal or strip construction of cities in these regions or the cities overlooking the mountains, live in the foot of mountain due to good weather of mountain and such extension affects the city construction and creates a type of social classification and it is effective on city texture. It means that in high areas and great areas of mountain foot and non-dense areas (villas and great houses with less traffic) can be created but in low areas with unsuitable weather, the city texture is small, dense and compressed (small houses, multi-stories with various alleys). It seems that among climatic elements, sun ray and wind are effective more than other items in construction namely, city texture.

Dezful town

Dezful town is located in longitude 48°, 24’ eastern and latitude 32°, 22’ northern. The sea level is 140m and it is located in plateau areas of Khuzestan province with the area of about 4762 km2 and by considering its rural areas, its area reaches 7844 km^2. Dezful is hot and humid city. The humidity of this city reaches sometimes to 60 to 70 degree and with environment heat, it is not tolerable and the historical architecture and texture of city is based on such climatic condition. The annual mean rainfall is 250mm and temperature mean is 3 ℃ in winter and 49 ℃ in summer. The materials of buildings besides structure capability and economic issues and providing the materials from close areas show the best form of using energy of environment.

Table 1. The climate of Dezful

Dezful climate													
Year	Dec	Nov	Oct	Sep	Aug	July	June	May	April	March	Feb	Jan	
48	26	33	40	45	48	48	48	47	37	32	30	23	Hottest, C°
30	17	24	32	40	42	43	41	36	28	22	18	14	Average hottest, C°
18	9	11	18	24	28	28	27	23	17	12	8	7	Average coldest, C°
-3	-2	---	5	12	16	20	17	12	6	-2	-2	-3	Coldest, C°
32	6	2	1	1	---	---	---	1	3	5	6	7	Rainfall, mm
Source: dezful.ostan-khz.ir													

General features of hot and humid climate

Low annual rainfall, high air humidity, mild winters and very hot and humid summers, very low temperature fluctuation during the day due to the humidity, salinity of underground water, low vegetation

Urban texture: The shade and air flow are two forming factors of urban texture and building form in this region. Creating semi-dense urban texture, relatively open rural texture, development of cities and coastal villages along the coast and overlooking sea are the features of urban texture of this region.

The direction of buildings: Based on the sun ray angle and other climatic factors in this region, the best direction of building is ranging from 5 degree of southwest to 15 degree of southeast and the best angle is 5 degree of southeast.

The direction of lanes: The direction of lanes as western-eastern directions and 45 eastern degree are the best based on the interference of two low temperatures and the lack of sun ray and avoiding the hot wind blowing and also they can avoid sun heat increase in streets and lanes. Dezful city is located in a specific geographical situation, topography and effective climate systems on region, it has specific climatic conditions and long-term heat and sun ray provide many problems for the residents of this city. Thus, we investigated sun ray as the most important effective factor on formation of this texture in this region.

Sun ray and its impact on building and surrounding environment

Sun ray is required to create natural lighting in a building but this light is turned into heat and the required sun ray for each building is determined based on its type and climatic conditions of the location. Thus, the amount of sun ray and the relevant heat in an area of earth depends upon the distance the sun ray should take, cloud thickness and air pollution. Thus, the amount of sun ray is consistent with its height from sea level and in high areas, the sun ray takes less distance from atmosphere and it produces much heat. Also, at local noon of each region in which sun is at the most vertical direction to the earth and its distance is less, sun ray is higher than morning and afternoon as the sun is at its oblique direction to the required earth. It can be said that sun ray amount in each location depends upon the sun location to that region. As the position of sun is different due to the circular movement of earth in different hours, days and seasons, to investigate the amount of sun ray on various levels and the heat, the sun location to the required place at different times should be definite. To do this, in this section, the sun location is investigated.

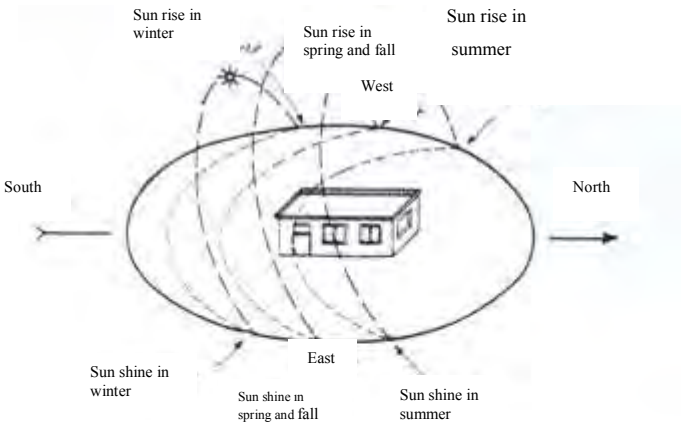

Figure 1-Sun location in various seasons of year

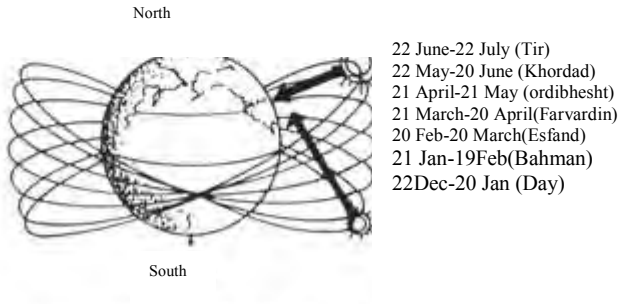

Figure 2. 1-Sun location and sun ray in summer
2- Sun location and sun ray in winter

The effect of sun ray and transferring sun to the spaces inside the building

As it was said, the energy amount affects the external surface and building roof and this energy is directed from the ceiling and latter walls to the building.

The type of materials in the construction affects the thermal conductivity into the interior spaces. For example, in stone materials with compressed molecules and if the effect of thermal energy is high, by walls and two-wall ceiling or appropriate materials, we can avoid the influence of much heat and coldness to the building and interior spaces. In this case, we should consider the doors and two-wall windows. The thickness of walls and using empty blocks and hollow brick can have great influence (Figure 3, 4).

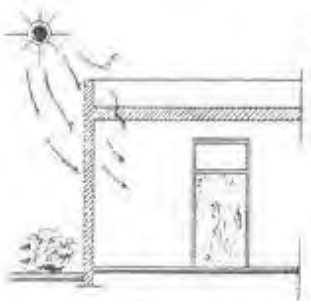

Figure 3. The direct effect of permeability

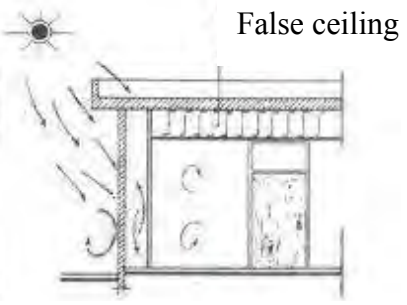

Figure 4. Two-side wall can neutralize thermal influence

The impact of traditional architecture on environment heat

In traditional architecture and central, southern and desert cities texture and villages of these areas, the ratio of hot climate, hot and dry, humid and hot and unsuitable winds are effective on urban or rural texture. The weather and type of climate are the issues people overcome with 1000 years of experience. Probably, there are many problems for living of people, hot and dry, hot and humid climates as burning sun, high heat and difference of temperature and its fluctuations in a day and its reduction in night breeze are taken into attention. Difficult summers and cold winters of desert area and dusty storms and dry, hot and unsuitable winds caused that people think about the required solutions. After 1000 years of experience, there are many solutions in various forms for this important issue all over the world, namely Iran and their aim is comfortable individual life and social places.

The applied materials in traditional architecture of Dezful

The applied materials in this region are mostly made of muddle, mud brick and brick. These materials are found abundantly in the region and they are provided with low cost and they are highly applied in this region. From climatic views, these materials have high performance as they become hot late during the day and they lose their heat late at night and this reduces heat fluctuation in building. From climatic performance issues, we can compare two yards, one in a modern house, another in tradition building of region. In the yard of current houses, mosaic, asphalt, fence and iron doors are used. These materials absorb sun rapidly and it is not possible to walk barefoot in summer afternoons on the floor of yard or touching the fences and metal doors. But, in traditional building yard, brick was applied and the temperature on brick is less than asphalt and mosaic and during the night, the brick keep the heat as late and the yard will not be cold early. In this region, wood is used for door and window and column of Iwans and horizontal beam in the ceiling. Stone is used mostly for foundation and footing.

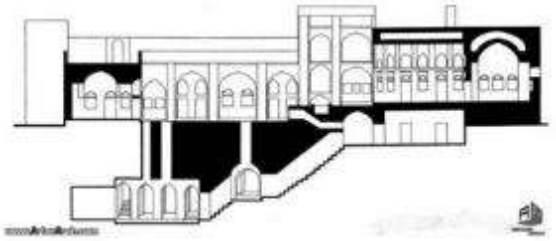

Figure 5. A view of residential houses of Dezful

Definition of Shavadan

The term Shavadan is derived of Shuta Povata according to the book of Partian and Sasanid era (Enayatollah, 1998, 292). This term is observed in the oldest texts regarding the underground spaces in Pahlavi language and it means sharing digging Kat[1]. Some of the theorists consider it based on the combination of Night+Abadan but as Shavadan is used at very hot time (noon), the first root can be emphasized more (Bina, 2007). Shabadan is cooler than Shabestan and when Shabeshtan air is very hot, they use Shavadan entering from yard (Shaterian, 2008, 370). Shavadan is an underground space dug under traditional regions of Dezful and based on the stable material of the earth in this region, it is dug (without wall or ceiling), with the depth of more than 10m from the ground and it is used for daily resting in summer and storing food and cooling requirements. These places are similar to Sardabs (basement) in Iran but there are some differences including Yazd

[1] KAT"s are resting places at the river side, especially in summer time

sardabs. The temperature in Shabadan is 25℃ but the surrounding street temperature is 54 ℃. Shabadan has different temperature based on its volume and depth and the higher their volume and depth, the cooler and stable the air. During using the cool weather of shallow Shabadan, their depth is not exceeding 27degree (Bina, 2007)

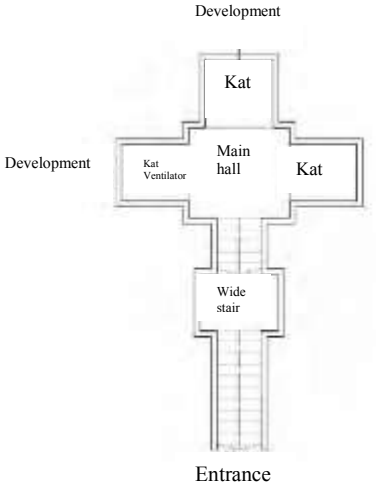

Figure 6. Parts of Shavadan

Entrance: Shavadans have a wide entrance (2/1m/1/8m) located in a part of yard. In some cases, they are located in a small porch beside the yard and they don't have any door and parapet wall is performed for safety.

Stair: It starts from the stair and continues to Shavadan main hall (Sahn). These stairs are steep than the modern stairs.

Wide stair: In each stairway, a wide stair is considered as berm before every continual 12 stairs and its performance is beyond a berm and its space is applied if the number of users is more than Shavadan capacity.

Main hall (Sahn): Sahn is the main part of Shavadan with square plan (sometimes it is multigonal). In big Shavadans, the difference of main hall difference from other parts leads to identity formation and the main hall unites all its parts.

Small Rooms (KAT): Except the first one being connect to stairs, three other sides are attached to the small rooms which are called "KAT". KATs are separated at most by a surface difference from Sahn. The term KAT as a part of Shavadan is used in other architectures of Dezful. There are some hills with the height 20-30m with continual and dense soil and stone beside the river. There are some holes for resting inside these hills (completely natural) and they had different applications in the past but now they are used for recreation and resting. These spaces are continual and connected to each other and are called Kat small divided spaces are called Katul (Shaterian, 2008, 371).

Underground passages (Tal): Shavadan Kats are connected to neighboring Shavadans via a tunnel or ventilation and it is called Tal. Indeed, Tals are underground communication network for a group of house with family or near neighborhood relation. The house located near the river or Qanat is connected by Tall and it has the cool current of air of Qanat.

Vertical passage of air (Derizeh): There was a ventilation duct in some Kats or main hall of Shavadan and it is named the small door and it is called Derizeh. It is also called Sisara in Shusta (Ibid). The Kat space absorbs air and light by Derizeh. Some the Derizehs have a way to the yard and others lead to alley and these Dezires also have a way to house rooms. The outside air enter

Shavadan space and enters the rooms after being cooled and make the room cool and the air is changing in this way (Shaterian, 2008, 370). By investigations of 7 houses in Dezful, all the Shavadans are not connected. Some of the spaces are only specific for the same house and they have no way to the neighboring Shavadan space. It can be said that most of the underground spaces are connected. In the past, in order that the residents are less exposed to sun ray and hot weather (day), barter exchange was performed in these spaces to observe the neighbor border (Shaterian, 2008, 370). This space is also acts as cool basements in the hot summer of Dezful and with the holes continuing to the house rooms, the dry air is sent from the earth to the rooms. In this space (Shavadan) has some places to store food. For example, meat is hanging from thick chains from ceiling. The only excuse taking a person outside of Shavadan is baking bread. In this type of architecture, communication is vertical not horizontal.

Air and its effect on Shavadan: Beside earth temperature cooling Shovadan in summer, Shovadan air ventilation plays important role in increasing its coolness. If Shavadan air is ventilated by cooler or hotter air than natural air, besides changing its temperature, its walls lose the heat. To make Shovadan cooler, there are some holes for entry and exit (circulation) that in case of cold air entrance, Shovadan walls get cooler than earth temperature.

Ventilation and holes of Shovadan: The entrance and holes of Shavadon should be as rapid ventilation during night is possible but to keep the stored air during days, no ventilation can be performed to avoid heat. The entrance with wide opening in yard, directs cool air of night to Shavadan in the way of low areas. This direction is achieved if the existing air in basement is taken out. Shavadan vents act as fan. They take out hot and light air of the past day to have new and cold air of night. During the day, as the hot air movement is increased naturally, in case of open holes, no ventilation is occurred unless the wind blowing in front of some holes increase air pressure or reduce air pressure in order than ventilating air flow from high pressure region to low pressure region in Shavadan. Thus, in the design of Shavadan, the location of wind breakers and building form are considered as such condition is not fulfilled (Bina, 2007).

The reasons of coolness of Shavadan

There are some reasons for coolness of Shavadan as follow:

- The most fresh and cool air in Shavadan is used and it is the air that is stored in the previous night.
- Storing coolness in the walls of Shavadan is another point that is used in the middle of summer. In very hot days in which providing cool air is rare for Shavadan, coolness of walls affects Shavadan air and make it cooler.
- In Shahrivar, after consuming the stored coolness in the walls, another appropriate feature of Shavadn is earth temperature factor (the same temperature of earth and comfort temperature as 25 degrees) and Shavadan air becomes cool.
- Another important point is the role of air vents of Shavadan and they should lead to the rooms and spaces of building to create air flow during night in the rooms.

Iran has great graces to the world but unfortunately, we are not aware of them and “Sabat” is one of them. This term is used in all eastern, western, Arami, Iranian, foreign and Tazi languages and it has old root in Persian.

Sabat

The first part “Sa” means comfort and the second part is “Bat” indicating the building and prosperity and it is used at the end of many words as Rebat, Karbat and Kharabat and the like and it means resting area (Pirnia, 2004, 231). Sabat is referred to all the buildings for comfort in the city or

outside of it, in the southern towns of Iran, this term is used appropriately… but today, Sabat specifically is used for a small closed area being built on the roads outside of city or beside them and it is restricted to some beds and an Abanbar and sometimes one or two small rooms that can be used to rest and comfort after taking a long way (ibid).

Figure 7. Sabat of Mola Haji in Dezful

Typology of Sabat

In terms of ceiling: Sabats with flat ceiling using wooden straw beams to keep the ceiling weight and two walls along the alley were bearing walls. The sabats with vault can bear the ceiling weight well based on static issues and transfer the weight to the columns, walls and then earth. The brick sorting method of the ceilings is based on Roman method. From the type of use in which there was above Sabat ceiling, the sabat with residential use on the ceiling and with rooms with one or two openings and a good view to the alley, the sabts only bearing the load of ceiling and they were the path connecting the houses in two sides of alley.

Functions of Sabat: One of the main functions of Sabat is giving shade and cool space to the pedestrians who want to rest after walking in long alleys in the hurting heat of the south. The temperature of the space under Sabat in summer or winter is good always! As in summer, the difference of inside and outside temperature of Sabat creates air flow and this makes the air inside Sabat cool compared to the outside. In winter, due to the enclosed space inside Saba compared to the outside space, the inside air is hotter than outside environment. Another important function of Sabat is uniformity and stability of its neighboring houses as this element helps the building to bear the forces. In many cases, by destroying a Sabat, the neighboring houses are destroyed. In addition to physical function, Sabat has other function more important than the first type and it is its social and cultural functions. The uniformity and continuity created by Sabat in the houses of a township, causes empathy among the residents of the township. In the past, local Sabat was considered to gather the residents of township and the gatherings caused the awareness of residents of townships and finding about their problems and solving the problems with each other aid. When we pass under the Sabat, the sudden shade causes that we bend our head and this means being released of pride and selfishness. In new urbanization, Sabat has no position and it is possible to seem extra, based on the explanations, the result is that "Sabat is not extra and it is a virtue that is forgotten! (Esteghlal, Bahadori, 2007).

Using brick for RIYA: The lattice brick wall of roof is called Riya. The netted bricks facilitate the air flow. The roof is used for sleeping, living and service space in some months of year in Dezful. Riya is mostly used as lattice course by complete or semi-built brick, the height of this brick wall is as the height of human being.

Conclusion

Performing suitable methods in building design with consistency with region climate, are always considered by architecture experts. In Iran, climatic regions and weather conditions are

different in various seasons of year. Traditional architecture innovates logical solutions and methods to provide comfort of people. Today, despite raising the consistency with climate, all the principles were used by our ancestors. The reason of reviewing the past solutions to be adapting with hard weather conditions is that the architecture of those days is the result of continual process of local architecture being transferred from one generation to another one in a long time. Dezful is a hot and humid city. The humidity of city ranges 60 to 70 degrees and when it is with heat of environment, it is not tolerable. Thus, the historical texture and architecture of city is created based on the climatic conditions. The difference of Dezful from other historical textures is its architecture importance in buildings and houses of people. By the investigation of the solutions in traditional and local architectures for consistency with environment, namely when the human being was obliged to use clean and natural energy, we can learn from the current architecture. The present study attempted to investigate the features of traditional architecture in Dezful city and hot and humid climate to refer to the traditional architecture to be consistent with the climate and living place.

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