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Typological study of physical structure and climate characteristics of traditional houses in Dezful

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Abstract: Over different ages and eras, Iranian traditional architecture with its old rich possessions has tried to create and make an optimal and perfect environment to live in. One of the most important and tangible issue in Iranian traditional architecture is to pay proper attention and awareness of climate conditions and human comfort in the environment and to make an effort to use climate elements and consider climatic designing to construct Iranian traditional houses. Iranian architects have attempted to create an optimal environment with proportion of intercalary direction and control dimensions and mass ratio and physical ratio of buildings in order to control climate conditions and even use climate elements appropriately. In this paper that is a descriptive article and has collected information by library and field methods has attempted to have a typological study on the physical structure and dimensions and sizes of traditional houses by Dezful climate conditions taken into consideration, and it will discuss some questions: what are the structural parameters considered by the Iranian architects when designing the mentioned houses according to climate conditions? Do the structural elements and also ratios and dimensions of houses in Dezful could be effective on creating a physical optimal condition? And finally, how could the given parameters affect creation of an optimal environment (positively/negatively)? Consequently, the following results have been obtained: Some of the effective climate parameters on houses in Dezful have been identified and studied. The basic effective structural elements on climatic designing of traditional houses in Dezful play an important role in creating physical spaces of traditional houses in Dezful along with high positive effects. Dezful houses possess many climate conditions and considering such conditions have made it possible for people to live in such survival and living conditions in the city.

Key words: Climate; Climatic designing; Comfort; Dezful; House; Physic; Structure

1. Introduction

Synchronously with global energy crisis and consistent with all other industries and fields, architecture is also trying to present better strategies to use, control and save energy consumption better. In this regard, in addition to technological aspects and architectural sustainable design, vernacular and local architectures for any region, and methods and solutions to deal with and/or utilize climate elements to create a suitable life environment have been discussed and studied as one of the most interested categories.

Humankind deals with the environment in many ways for his heat comfort. And also, he has learned by experience that with the aid of architecture he could keep his surrounding space under an appropriate heating condition, although he has not been always successful in the latter and sometimes the human shelter itself causes thermal discomfort (Razjuyan, 1986). Over the entire history of architecture and building construction, designers have sought to respond climate conditions. (Watson, Donald et al., 2009) Even in the so called "primitive" architecture, climatic designing have had an accurate and elaborate expression whether in the rural buildings located at Alps in Switzerland or in the traditional house plans with central courtyard. (Watson et al., 2009) In vernacular buildings and local styles, climate has been considered a basis for human life and activities from which shapes and aesthetics of the buildings have been resulted. Watson, Donald, Lebz, Kennet, 2009. Climatic designing is a method to reduce energy cost in a building (Watson et al., 2009). In all climates, buildings constructed according to climatic designing principles minimize the necessity of mechanical heating and cooling and in turn use the energy that exists in surrounding area of the building (Watson et al., 2009). Costs that are saved in the long-term make performing the climatic designing techniques the best way of investment for building owners (Watson et al., 2009). Vernacular and traditional buildings for any region are products of the experience collected during ages and could be a permanent source of knowledge. Utilization of local environment-friendly materials and local climate is some of factors resulting in a distinct architectural identity in any region. Today, with increasing global attention to reduction in the artifact environmental

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pressure on the natural environment and utilization of inactive designing methods to meet cooling and heating needs of the building to reduce energy consumption, it seems necessary to pay attention to patterns of vernacular designing in our country. (Taban and Mohsen, 2013) In most of the developed countries and academic spaces, many researchers have been conducted in this field and continue to be conducted. That is the main reason why different researchers have studied the vernacular and traditional buildings throughout the world with respect to the bioclimatic and environmental architecture. These researches address the environmental performance in traditional architecture by both quantitative and qualitative methods. While quantitative approach studies basic measurement in situ for different climate parameters in and out of the buildings that results in conclusions about thermal performance of the house, qualitative approach includes environmental performance of various elements of buildings and/or developments related to dominant climate conditions. In the present paper, it is tried to have case study on the climate architecture and parameters considered in this type of architecture in Dezful. First, climate and its parameters are discussed.

2. Climate

Climate derived from Greek word "clime" and generally refers to weather conditions of the earth (Moradi, 2008). Climate and physical factors include solar, air, humidity, and several other factors form the earth climate situation or status. Gravity and thermal forces are also effective factors on the earth climate condition (Moradi, 2008). Air pressure, temperature, geographical location in terms of typology are all considered effective factors on the climate conditions in the continental scale (Moradi, 2008).

With respect to diversity of contents and climate parameters, it is tried to address the discussion generally as shown in the following Table 1.

Table 1: Climate elements and parameters (Source: Author, with an emphasis on the book Climate study of Iranian traditional buildings, Gobadiyan, V. 2005)

Climate	Definition	Derives from Greek word "clime" and generally refers to weather conditions of the earth. (Moradi,Sasan,2008)					
	Determinant Parameters	.....	Specifications	effects		Architectural approaches	
				Useful	Harmful	Winter	summer
		Angle of solar radiation	Due to deviation of axial tilt of the earth, angle of solar radiation to earth and also locations for sunrise and sunset vary for different seasons.	Change in the locations of sunrise and sunset, advent of different seasons, receiving solar energy, and heat gain as stored in the building	Lack of control on solar energy and gaining extreme energy in the building make increased heat in the building.	Increase in heat gained, prevention of heat dissipation	Prevention of heat gain, increase in heat dissipation

		Latitude, i.e. remoteness or nearness to the equator	One of the most important factors in any local climate condition is its location on the earth, i.e. local latitude.	The more vertical solar radiation the more thermal effect it will have. In geographical circuits, depending on remoteness or nearness to the equator, temperature is colder or hotter.	Lack of control on solar energy and obtaining extreme energy in the building make increased heat in the building.	Increase in heat gained, preventing heat dissipation	Prevention of heat gain, increased heat dissipation
		Intensity and direction of seasonal winds flow	Difference in temperature and pressure along with earth rotation cause movement of air and as a result, movement of wind.	Because wind has rain clouds and also rain with itself that are required for life, living on the earth is impossible for humans without wind. Wind plays a role in temperature transfer and ventilation in the building.	Wind is effective on sound transfer, air pollution, and smells. Undesirable winds play a role in creating undesirable conditions in the building.		
		Presence of humidity and plants in the region	Due to thermal capacity and specific heat, water is more capable of conserving heat as compared to the average heat storage in other objects on the earth.	Presence of water resources allows for moderate temperature and water could reduce temperature fluctuations in the building.	Presence of relative humidity of air beyond human comfort causes an uncomfortable condition in the building.		Utilization of evaporative cooling to cool the building
				Plants play an important role in cooling the environment due to evaporation. Directing and reducing intensity of wind characterizes trees.		Utilization of evergreen trees on the western side of the building	Utilization of broad-leaved trees on the western side of the building

		Altitude and earth surface roughness	Terrain accidents are also highly effective on driving wind towards building. Earth surface roughness and vegetation soil type and climate conditions.	Climate elements and temperature fluctuations have little effect on underground constructions and as a barrier, crust of the earth protects the building against these changes. The more deep the building embedded in the earth, the less temperature changes will occur because of larger soil thickness.			

2.1. Types of climate

Climate conditions and quality in a region determine climate type of the region on average that is distinguished from climate quality of other regions. Although the earth climate conditions are divided into 32 regions form an aero logical perspective, and into 16 regions from an agricultural perspective, these classifications could not be applied on the architecture and designing physical environment. Hence, in order to apply it in the architecture, Iranian climate conditions have been classified into four regions: cold, moderate, hot and dry, and hot and humid (Moradi, 2008).

2.2. Climate and architecture

Understanding architecture for any era and region requires awareness of how to match its details with climate of a specific region. Architecture could never be separated from its surrounding context circumstances whether natural or artificial. Therefore, with respect to the climate conditions of the region, any geographical situation demands a specific architecture. When the urban context, building form and type of materials for any region are absolutely consistent with the climate conditions, they could have their best performance.

Iranian traditional architecture has responded architecturally and appropriately to the nature and climate and over any period it focused on creation of the individual comfort in the environment and on its maintenance. As seen in the Iranian traditional architecture, in the cities like Yazd, architecture consistent with the climate has been created to deal with the regional very hot weather; and in the cities like Kermanshah, architectural designing has been performed with respect to its cold weather. It is clear that the climate factors have been taken into consideration in other regions such as north, south, and the Persian Gulf margins.

In Iran, what is treasure of climatic designing includes wide range of architectural designs of the residential areas that not only involve formal and qualitative aspects of the environment but also selection of materials, color, structure, etc.

Travelling in this wide area and from a house to the urban areas and tracks and changing scale from large to small have accompanied the ecological architecture of the region with respect to human biological factors and activities along with climate factors of the region because human and his needs is the main factor in how architecture is formed and one of the main objectives in designing construction is to provide physical comfort for users.

Looking at the results from studies in traditional architecture, it seems that all techniques of designing consistent with climate that are considered in designing buildings are of much interest in traditional architecture of our country especially in desert regions like Isfahan.

How to take these factors and use them to create conditions for human comfort have allowed for some methods that are taken into consideration in old architecture of Isfahan – and considering that geographical factors effective on the region and Isfahan are related to hot and dry climate – and introduce Isfahan to the world as a city consistent with climate.

The important issues associated with urbanization linked with the region climate and geography and affected by them is sitting direction of the house, or as professor Pirniya said, "roon" with respect to direction of the solar radiation. It has been affected by climate, radiation, direction of fresh

wind, storm …, location, and material of the earth. (Issue,Danesh nama)

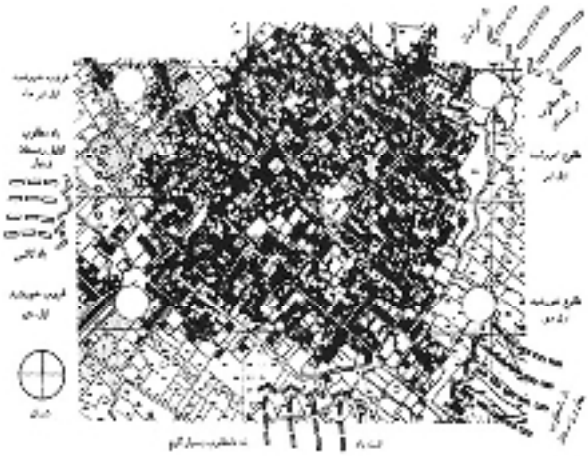
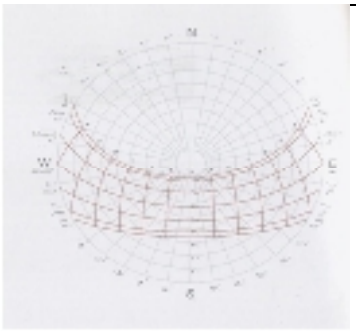


Fig. 1: Structure of city formation affected by climate

Climate and environmental condition have specific and inevitable physical and psychological impacts on human that should be considered in designing buildings depending on the heating and cooling situation. Designing construction by using solar energy coupled with attention to local climate characteristics and building materials not only could create comfort condition in the artifact environment but it will help to reduce energy consumption (Yaglou, 1972). It is clear that level of internal temperature for a building could be improved by using inactive solar techniques that is effective on thermal absorption of building shell including creating shadow on the external shells, using materials with high thermal capacity, and appropriate orientation (Gandara et al., 2002).

2.3. Here, we are going to discuss climate considerations of Dezful generally.

Table 2: General information of Dezful (Source: Author, with an emphasis on information from governmental organizations of Khuzestan and the book Climate and architecture by Kasmayi and Historical geography by Imam Ahvazi, M.A.)

An overview of Dezful			
Dezful	Appellation		Dezfil, Dezpil, Dezpehl: creating a city beside the old bridge that has allowed for the connection between two sides of Dez river.
	Situation in the country, population, area		Dezful with 7884 km2 area is located at 155 km from north Ahvaz, between the latitude 32 degrees and 24 minutes north and longitude 48 degrees 24 minutes east to Greenwich meridian.
	Natural status		Physical face of Dezful could be divided into three different areas including mountainous area, foothills area, and plains area
	Geology		Due to the specific geographical status, various vegetation, ranges, and agricultural lands, types of soil in this region is classified into 6 types in terms of formation and establishment of natural factors: mountainous areas, plateaus, hills, plains, debris, mixed
	Water resources		Generally, water resources for Dezful are divided into two groups of subterraneous and surface waters.
	Vegetation		Dezful is the greenest city in Khuzestan province with per capita green space of 15.2 m3 and generally it has coverage of ranges and gardens.
	Factors of city limits		Heights, agricultural lands, Dez river
	Climate Climate	Temperature	According to the information from Safi abad weather station in Dezful, the average lowest temperature for Dezful has been reported 2.19 °C (22 Dec- 20 Jan) and the average highest temperature has been reported 50 °C.
		Precipitation	According to 15 years weather statistics, maximum annual precipitation in Dezful is 372.6 mm.
		Relative humidity	Average maximum humidity in Dezful is 95% and the minimum 14% over the last years.
		Dominant wind	Direction of dominant wind in Dezful is from south west.
		Altitude	143 meters
		Diagrams of directions for solar radiation and for wind	 

2.4. Specific climate and physical conditions of Dezful

Humidity in regions like Dezful (where average relative humidity at 6:30 in the morning is 59%) is lower than humidity of Adjacent ports of the Persian

Gulf such as Abadan (where average relative humidity at 6:30 in the morning is 63%), however it is more than that for hot regions in Iranian central plateau such as Yazd (where average relative humidity at 6:30 in the morning is 43%) (Ghobadian, 1994).

With respect to the temperature and relative humidity, this region could be considered between hot and dry region of Iranian central areas and hot moist region in south coast of the country. ()

For two ancient cities of Dezful and Shushtar both with old urban textures in large scales, it is observed that hot and semi-humid climate allowed an urban texture and a form of building to be created that have an intermediate state between urban texture and form of building in two regions of hot and dry, and hot and humid (Ghobadian, 1994).

Dezful has a hot and semi-humid climate with a hard and relatively sultry summer. Despite the fact that the people living there have a specific cultural identity, designers and constructors have always attempted to shade and create natural ventilation in their own vernacular architecture (Ghobadian, 1994).

Because of severe heat and relatively high humidity over about half of the year, bilateral ventilation in the building is necessary in order to deal with this extreme temperature and humidity and that is why constructions in Dezful are semi-introvert and splays are placed on the internal and external surfaces of the building (Rahayee, 2013).

Because of the specific climate conditions in Dezful, we have tried to consider both hot and dry, and hot and humid climates:

Table 3: General structural specifications of buildings in hot and humid climate (Source: author, with an emphasis on the book Adjustment of environmental conditions by Moradi, S.)

	Form of building	In hot and dry regions, due to high intensity of solar radiation at east and west, it is necessary for buildings to have stretched forms and cubic shapes along east-west axle. Shadowing in the surfaces and facades by using wide porches, placement of the main spaces at floors above the ground and service parts at ground floor, houses have central courtyards and generally, they are semi-introvert.	Cold climate The climate is mild and humid The climate is hot and dry The climate is hot and humid 
	Splays	Splays have large dimensions but they are usable only when they are not at the external environment together with very hot weather. When temperature and humidity is high, splays are closed. In order to make the best of breeze and draft, heights of rooms and windows are long and high and porches are large and high.	
	Roof coating	Roof coatings are flat and residents sleep on roofs at night. Roofs have grid parapets so that air flow is done easily in addition to protection from surrounding views.	
	Building material	With respect to temperature balance, using materials with high thermal capacity is not reasonable. Using wood in building shells and walls is an appropriate solution to prevent entering temperature into the buildings. Buildings are often constructed with clay and mud and materials with high thermal capacity.	

Table 4: General structural specifications of buildings in hot and dry climates (Source: author, with an emphasis on the book, Environmental condition, by Moradi, S. 2008)

		In hot and dry regions, plans are compressed and compact and the external surfaces of the building are minimized relative to its volume and the maximum shadow is created on the surfaces. Houses have central courtyards that indicate well-known beautiful form of Iranian traditional houses that has been created frequently since prehistory up to now. Buildings have parterre and pool at courtyard. Conformity of life styles with regional climate conditions characterizes such areas. Rooms surrounding the yard are used according to climate conditions for different seasons.	
		Splays at the external surfaces and to passages are kept as low as possible. Splays connected with the external environment are installed in the upper part of the building walls. The largest surfaces of splays open to the protected area of the central courtyard.	
		Ceilings and roofs are often arched and domical and constructed with clay and mud.	
		Buildings are often constructed with clay and mud and materials with high thermal capacity. In very critical conditions, buildings are placed into the ground and at the heart of the hills.	

2.5. Methods for climate control

Now we suggest some general solutions for climatic designing and methods for climate control:

Table 5: climatic parameters of Dezful (Source: author, with an emphasis on the same book)

	Elements of designing	Specifications and effects	Architectural approach
Climatic parameters for residential buildings in Dezful	Radiative cooling (A)	Absorption of solar heat during the day by heat-absorbing materials and suitable surfaces of heat receiver and reflecting it at night	Is not appropriate.
	Domed ceilings (B)	According to Bernoulli's law, because of increase in airflow	Is appropriate.

		speed at top of the dome, the domed ceiling loses more heat and become cooler at night.	
	Juxtaposition of buildings (C)	In regions with hot weather, cities have closed and compact textures so that they could be protected from solar radiation as much as possible.	Is appropriate.
	Color of building	In regions with hot weather, colors of buildings are selected bright and opaque so that they will have low solar absorption.	Is appropriate.
	Greenhouse effect (E)	Solar refraction on the glass and not returning from glass cause confinement of light and heating the space.	Is not appropriate.
	Thermal conductivity (F)	Ability of building materials in heat transfer and relocation	Is not appropriate.
	Plant water, humidity (G)	Cause reduction in the space temperature.	Is not appropriate.
	Embedment on the ground (H)	Ground insulation prevents heat exchange.	Is appropriate.
	Introvert and semi-introvert courtyards (I)	Creating appropriate light and ventilation in the building with protection from undesirable elements	Is appropriate.
	Courtyard surface to infrastructure surface (J)	Courtyard to infrastructure ratio tries to control levels of ventilation, light absorption, and heat exchange with the architectural space.	Is appropriate.
	Courtyard surface to building height (K)	It is used to make shadowing on the courtyard and creating a cooler and more pleasant environment in hot weather.	Is appropriate.
	Splays open to courtyard (L)	Using appropriate light and ventilation	Is appropriate.
	Ceiling heights of building floors and prevention of nested space in the building plan (M)	Building acts as a barrier against airflow. In the residual buildings, higher facades allow for more air pressure and as a result for ventilation in the building.	Is appropriate.

Table 6: Climatic parameters of Dezful, case studies (Tizno and Sozangar Houses) (Source: Archive of Ahuey, S.)

Climate parameters		Considerations	A	B	C	D	E	F	G	H	I	J	K	L	M
Houses in Dezful	Tizno House	In the discussion about the above-mentioned climate parameters, Tizno House is qualified with the given climatic			•	•	•	•	•	•	•	•	•	•	•

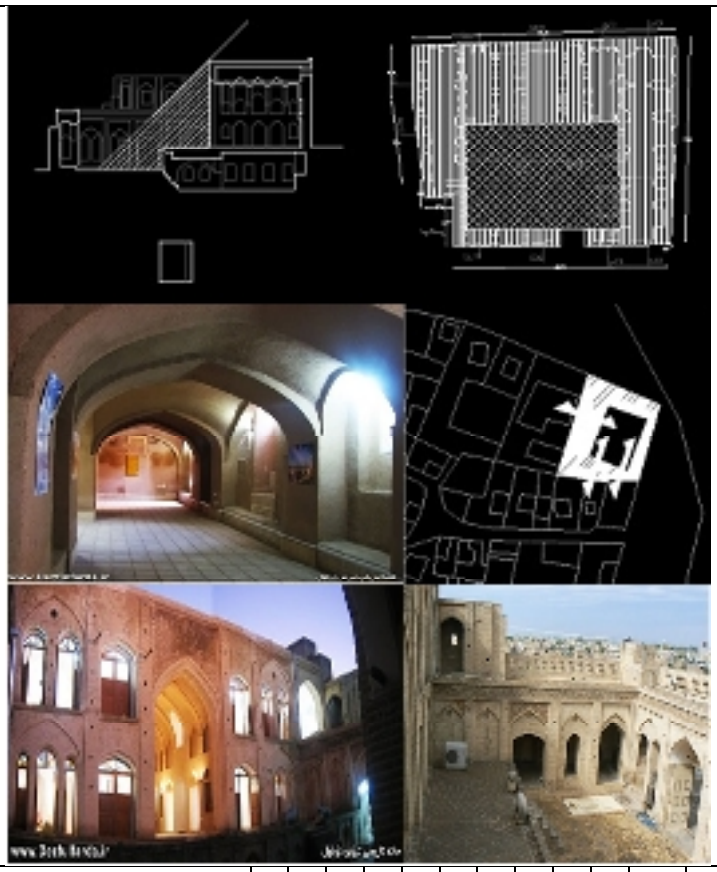
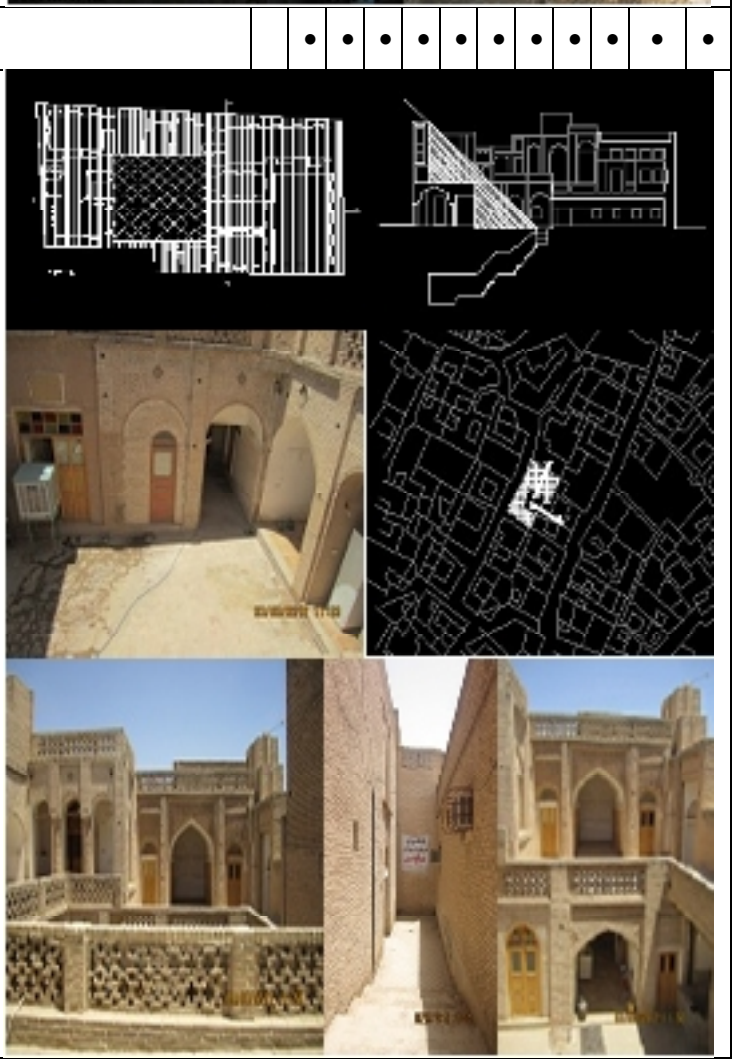
		designing conditions, in addition to obtaining the required scores. For proximity, it attempted to be located next to the rest of adjacent buildings so that a compact texture is created. Also, in this house, bedchamber has been used in order to achieve an appropriate thermal balance. It is noteworthy that in the discussion about protection from greenhouse gases, thermal conductivity, and water, humidity, and plant that are not appropriately designed according to specific climate of Dezful, Tizno House has been able to gain the score for this section and prevent creation of such condition in the building.	
	Sozangar House	In the discussion about the above-mentioned climate parameters, Sozangar House is qualified with the given climatic designing conditions, in addition to obtaining the required scores. For proximity, it attempted to be located next to the rest of adjacent buildings so that a compact texture is created. Also, in this house, bedchamber has been used in order to achieve an appropriate thermal balance. It is noteworthy that in the discussion about protection from greenhouse gases, thermal conductivity, and water, humidity, and plant that are not appropriately designed according to specific climate of Dezful, Sozangar House has been able to gain the score for this section and prevent creation of such condition in the building due to absence of the parameters.	

Table 7: Climatic parameters of Dezful, case studies (Ghalambor and Nilsaz Houses) (Source: Archive of Ahuey, S.)

Climate parameters		Considerations	A	B	C	D	E	F	G	H	I	J	K	L	M
Houses in Dezful	Ghalambor House	In the discussion about the above-mentioned climatic parameters, Ghalambor House is qualified with the given climatic designing conditions, in addition to obtaining the required scores. For proximity, it attempted to be located next to the rest of adjacent buildings, so that a compact texture is created. Also, in this house, bedchamber has been used in order to obtain an appropriate thermal balance. It is noteworthy that in the discussion about protection from greenhouse gases, thermal conductivity, and water, humidity, and plant that are not appropriately designed according to specific climate of Dezful, Ghalambor House has been able to gain the score for this section and prevent creation of such condition in the building.			•	•	•	•	•	•	•	•	•	•	•	•
	Nilsaz House	In the discussion about the above-mentioned climate parameters, Nilsaz House is qualified with the given climatic designing conditions, in addition to obtaining the required scores. For proximity, it attempted to be located next to the rest of adjacent buildings so that a compact texture is created. Also, in this house, bedchamber has been used in order to achieve an appropriate thermal balance. It is noteworthy that in the discussion about protection from greenhouse gases, thermal conductivity, and water, humidity, and plant that are not appropriately designed according to specific climate of Dezful, Nilsaz House has been able to gain the score for this section and prevent creation of such condition in the building due to absence of the parameters.					•	•	•	•	•	•	•	•	•	•	•

Table 8: Climatic parameters of Dezful, case study of Khalilo House (Source: Archive of Ahuey, S.)

Climate parameters		Considerations	A	B	C	D	E	F	G	H	I	J	K	L	M
Houses in Dezful	Khalilo House	In the discussion about the above-mentioned climatic parameters, Khalilo House is qualified with the given climatic designing conditions, in addition to obtaining the required scores. For proximity, it attempted to be located next to the rest of adjacent buildings so that a compact texture is created. It is noteworthy that in the discussion about protection from greenhouse gases, thermal conductivity, and water, humidity, and plant that are not appropriately designed according to specific climate of Dezful, Khalilo House has not been able to gain the score for this section and prevent creation of such condition in the building due to presence of these parameters.			●	●	●	●			●	●	●	●	●

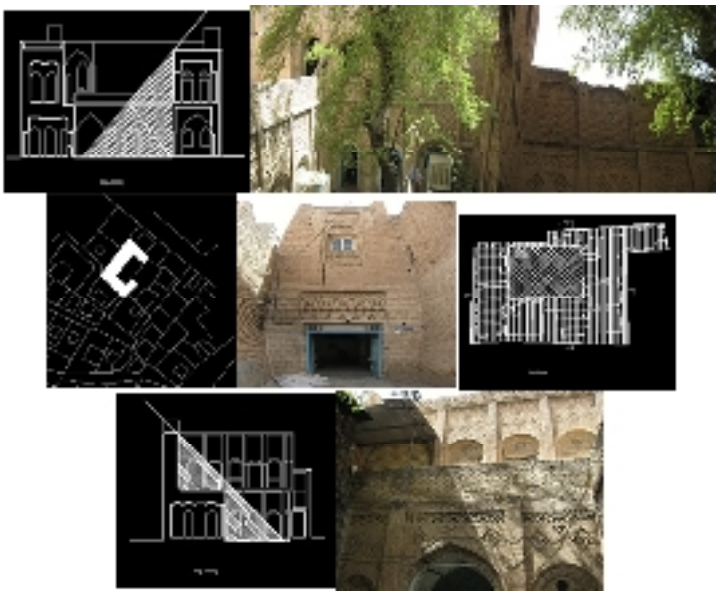


Table 9: Measurement of score and comparison of Dezful houses (Source: Archive of Ahuey, S.)

Climate parameters	A	B	C	D	E	F	G	H	I	J	K	L	M
Total score of buildings	0	0	5	5	5	5	4	4	5	5	5	5	5

3. Conclusion

Considering the above cases and measured parameters, it is observed that the study houses have gained high score of 5.5 for most items and for some parameters, they gained score of 4.5 that indicates in climate study, Dezful houses are highly qualified for climate conditions. Consideration of such matter has allowed for appropriate survival and life condition for people in this city. It is noteworthy that for two matters of radiation cooling and domed ceilings, the above-mentioned houses have not been able to gain positive scores, however they have high negative score of 5.5 according to negative measurements for items and it may be considered a disadvantage for the houses. However, they are not completely regarded as disadvantages and are considered advantages for the houses in winter and allow for internal heating conditions for buildings.

In hot regions, different strategies are adopted to control radiation energy outside the building that include using bright colors for the external shells, utilizing different shades and improving thermal characteristics of materials used in walls. Such strategies are observed obviously and numerously in the traditional houses of Dezful.

That is to mention that in traditional architecture of Dezful, intensity of received energy has been reduced by some strategies such as constructing porches in front of living space, decorative brickwork on the surfaces, making decorative and functional arches, etc. that is also evident in Dezful houses, according to data in the above tables.

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