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Assessment of Effective Factors in Sustainable Architecture of Qajar Period Historical Houses

Zahra Saedi¹ and Hossein Aali^{2*}

¹Faculty of Civil and Architecture, University of Eyvanakey, Iran. E-mail: ZAHRA_SAEDI@eyc.ac.ir

²Faculty of Civil and Architecture, University of Eyvanakey, Iran. E-mail: HOSSEINAALI@eyc.ac.ir

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Abstract

Sustainable architecture is one of the important evolutions in the field of architecture, so that its purpose is designing based on the principles of sustainability and energy saving. In Iran, the harmony of architecture with the properties of the climate for each region, has long been considered, including the hot and dry climate. A large part of Iran is in hot and dry climate condition that has features like intense heat in summer, wind and intense cold in winter. Therefore, houses should be built in such way as to be protected from direct sunlight and intense heat and winter cold; so in this type of climate, the architecture of residential houses is introverted and important. Many buildings have survived from the Qajar dynasty in Iran, so that most of them include residential houses. The architecture of this period has been called housing architecture or residential house architecture. The purpose of this paper is to identify and express the effectiveness of the principles and elements affecting the sustainability of Qajar houses in hot and dry climate, so the factors affecting the construction of ancient sustainable houses are studied by introducing 5 examples of such these houses in Qom city and the principles, harmony and adaptation of the body of these houses with their geographical environment are recognized.

Keywords: Sustainable architecture, House, Qajar period, Qom

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1. Introduction

Today, the concern of reducing energy waste and environmental pollution in architecture has created sustainable architecture. One of the concerns of Iranian architects is to build a house according to the culture, the climate and the special Iranian style. In this regard, to classify a building as a sustainable building, some principles should be considered including: energy conservation, climate harmony, reducing the use of new resources, meeting the needs of occupants, site harmony and totalitarianism (<https://1001boom.com>). Climate is one of the most important and effective factors in the design of residential buildings, so that its impact can be seen in the urban context, buildings and interior architectural elements of the environments. In Iran, the architecture of buildings and cities in hot and dry climates is one of the most

*Corresponding author: Hossein Aali, Faculty of Civil and Architecture, University of Eyvanakey, Iran. E-mail: HOSSEINAALI@eyc.ac.ir

obvious aspects of the of climate on the form and formation of cities and buildings. In this type of architecture, the building not only adapts to the climate conditions of its region, but also interacts with it (Kasmayi, 2005). According to Richard Rogers, buildings are like birds that cover their feathers in winter and adapt to new environmental conditions and adjust their metabolism accordingly. So far, the impact of climatic factors and the characteristics of each of them have been evaluated according to the urban context, building form, residential buildings and the type of materials (Qobadian, 2005) and the impact of indigenous architecture as well as elements and effective factors in creating sustainable indigenous architecture in different periods have been studied by contemplation and recognition the residential species of some hot and dry climatic cities. In this case, the most important principle is the adaptation of the body of these houses to the geographical and social environment (Me'marian, 1994). The question we face in this study is to identify the elements of residential buildings in the Qom city in the Qajar period and to assessment the impact of these elements. Since the principle of introversion is important in this city in two main ways, the first is to be located in a hot and dry climate and the second is the principle of privacy and religion, which is important (Negarandeh, 2020). The architecture of residential buildings in the Qajar period goes from the privacy and observance of external and internal spaces and generous designs along with the observance of the principles of communication and privacy, to the western architecture. This case affects the principle of privacy and introversion (Saremi, 1991 or 1997). According to the above, first Qom city is introduced and then its climate and geographical conditions are the principles of sustainable architecture are defined and the architectural features of Qajar period houses have been studied. Finally, the effective factors and indicators of sustainability in the design of these houses and the impact of Qajar architectural features in this building has been recognized by reviewing and presenting an analysis of several residential houses of the Qajar period in Qom city.

2. Brief Presentation and Geographical Conditions and Climate of Qom City

Qom province is located in the proximity of the central desert of Iran to the west and its area is 11,316 sq. km, which covers approximately 0.6% of the total area of Iran. It is limited to Tehran province from the north, Markazi province from the west, Semnan province from the east and Isfahan province from the south (Figure 1).

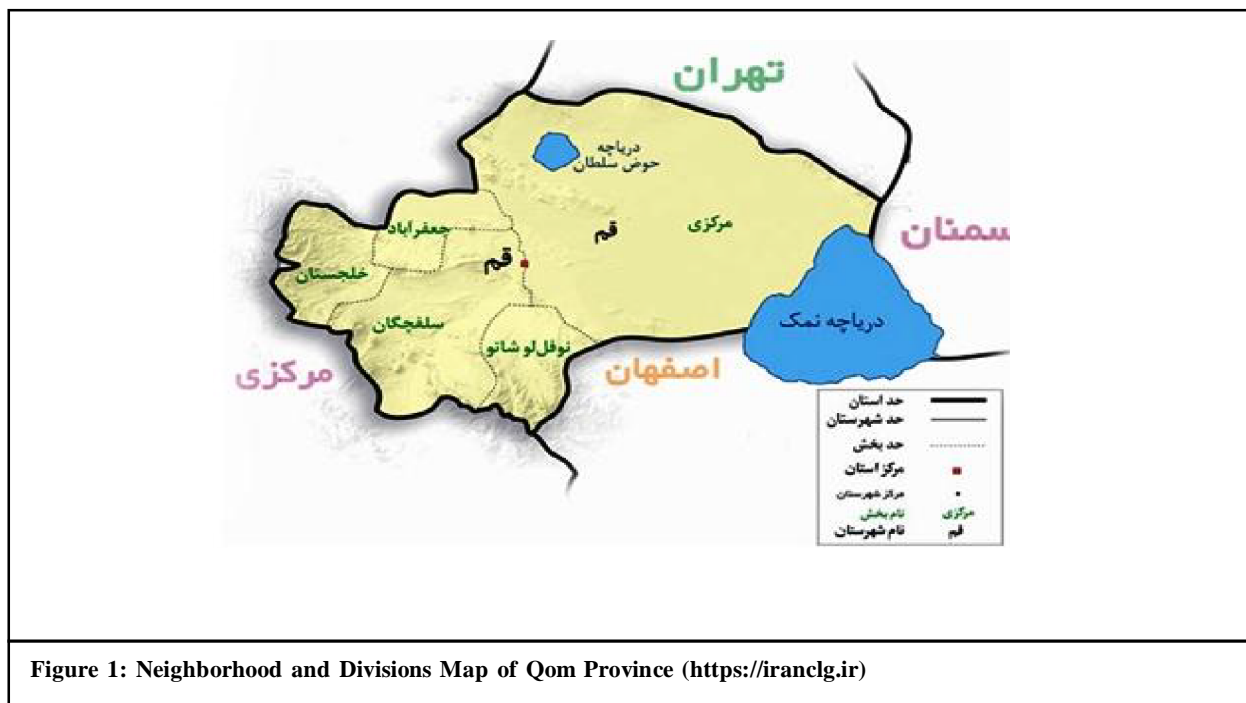


Figure 1: Neighborhood and Divisions Map of Qom Province (<https://iranclg.ir>)

In terms of latitude, Qom province is located in the middle latitudes of the northern hemisphere (between the pole and the equator), so it should have a temperate climate, but the interference of factors like proximity to the desert and altitude has caused changes and differences in its climate. So, that the effect of altitude is high in the western and southern areas of the province and there is a significant decrease in temperature in the heights. The whole province has low humidity because of its distance from the sea. Winds are considered as an important and effective factor on the climate of the province due to their effect on temperature, evaporation and rainfall. West and east winds are more

important than others, but east winds are more important than west winds. The east winds blow from the central deserts of Iran to the central and eastern areas of the province and bring a lot of dryness and dust, and cause air pollution of Qom city, because they blow from the desert (especially in autumn and spring). In winter, sometimes northeast winds blow into the province, causing intense temperature decrease, creating a phenomenon named dry cold. West winds affect the province, especially in autumn and winter, and often cause rainfall in the province. The Dominant winds in Qom province are eastern winds (<https://ghom.ir>).

3. Definition and Principles of Sustainable Architecture

Sustainable design, or ecological design, also called green design or sustainable architecture, is a philosophy. Philosophy of building design that follows the principles of ecological, economic and social sustainability.

According to the definition of sustainable architecture, the purpose of building design considering the principles of sustainability and ecology is to reduce energy waste and environmental pollution. In this type of architecture, the building not only adapts to its region climatic condition, but also interacts with it.

Iranian architecture with the historical experience and collective wisdom of the previous generations architects, looks at the heating and cooling methods of the building comprehensively, and avoids any extravagance at the same time. It is based on these documents that everyone believes that the Iranian ancient architecture in its period of time was a “sustainable architecture” (Hoseinian, 2003).

The concept of sustainability in architecture is not only to create buildings that live a long term life because a building with a lifespan of several years may not be compatible with the present needs. The architecture can be called sustainable that meets its present needs. The following features can be expected from a sustainable architecture:

- Minimizing the exploitation of non-renewable resources and using natural and renewable energy.
- Improving the quality of the environment and extending the natural environment.
- Eliminating or minimizing the consumption of contaminated and toxic materials.
- Protecting cultural and ethnic identity.
- Promoting healthy living, wise using of land and making harmony of building shape with the environment.
- Economical construction using alternative technologies.
- Coordinating the building with the environment and using construction methods with local materials as much as possible, efficient design and construction.
- Preventing noise and air pollution (Beyranvand, 2011).

4. Architecture of Residential Houses of Qajar Period

In general, the architecture of the Qajar period can be divided into two main periods:



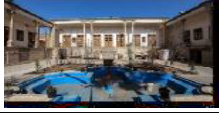


The First Period from the Beginning of Agha Mohammad Khan’s Reign to the End of Mohammad Shah’s Reign: the dominant view of architecture in this period is still an endogenous view and based on the style of Isfahan and perfecting it.

The Second Period, from the Beginning of Nasser al-Din Shah’s Reign to the End of the Qajar Dynasty: In this period, because of the travels of Nasser al-Din Shah and his descendants, as well as the sending of some Iranian students to Europe, a kind of architecture style begins that it is a mixture of indigenous and western architecture. The architecture of the Qajar period has also been called housing architecture or residential house architecture. During this period, because of population increase in the urban occupants, attention was focused on creating shelters and houses for new occupants in the city. In the field of architecture, due to the connection between the architectural art of palaces and people’s buildings, examples of this Western art quickly found their place among urban houses and penetrated all around Iran.

By the way, it goes without saying that in these cases it was a western plan, but the porches and other Iranian elements and mainly Iranian architecture with its decorations have inspired a completely local spirit into it and a much more pleasant and lovely collection has been obtained (Saremi, 1991).

Qajar period houses had included the central room, porch with two columns in front of it, small rooms located around the central room in a simple and detailed form, long plans along the building, creating a wide view by windows, embedding the house pond, creating two-way stairs in the main axis of the building, converting three doors into two doors and entering direct light into the building, diversity and lightness and more opening of spaces in sloping roofs and gables, that were a mixture of Iranian and European architecture (Saremi, 1991). The historical houses of Qom city, especially the houses related to the Qajar period, are part of the rich treasure of the history of Iranian art and architecture that have been less studied. According to the studies that conducted and the expert opinion of the Cultural Heritage, Handicrafts and Tourism Department of Qom city, most of the old houses have been destroyed for various reasons and have not been survived from the damages of the time. Among the houses of the Qajar period, the following is the introduction and review of five houses in Table 1, that have good architecture and have been identified and registered by the Cultural Heritage, Handicrafts and Tourism Department of Qom city, according to the principles of sustainable architecture and assessment of Its elements and indicators have been selected as case studies (Negarandeh, 2020).

5. Introduction of the Residential Houses Examples of Qajar Period in Qom City

Table 1: Introduction of Five Houses Examples of Qajar Period				
House Name	Area (square meters)	Location	Antiquity	Picture
Haj Ali Khan Zand House	400	Chahar Mardan District	About 120 years (late Qajar period)	
Haj Qoli Khan Zand House	200	Chahar Mardan District	About 120 years (late Qajar period)	
Yazdan Panah House	900	Bajak Street	About 120 years (late Qajar period)	
Shakeri House	600	Haj Asgar Khan district	About 130 years (late Qajar period)	
Mirza Mohammad Baqer Rouhani House	1450	Chahar Mardan district	About 150 years (late Qajar period)	

6. Assessment of Elements and Indicators of Sustainable Architecture in Residential Houses in Qom City (Tables 2 and 3)


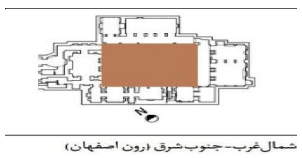
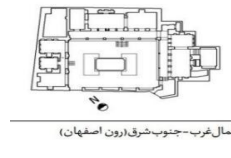
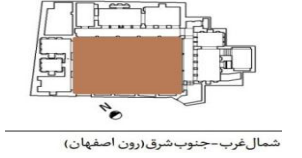
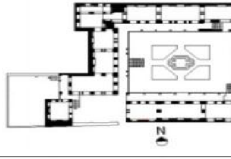
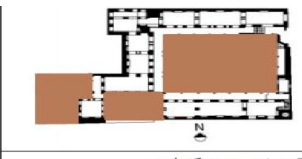
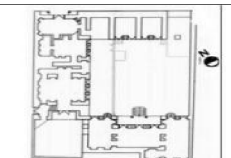
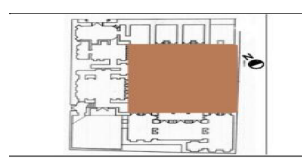
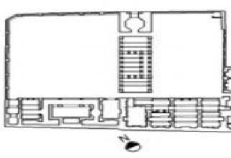
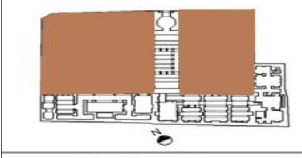
The most important architectural elements used in the historical houses of Qom city are:

6.1. Form and Plan

Density and compactness and low surface area to the volume of the building minimizes the level of heat exchange between the building and the environment, resulting in less waste (Mahmoodi and Nivi, 2011).

6.2. Introversion and Central Court-Yard

Creating central court-yard houses with high walls to trap cool air is one of the oldest ways for cooling. These court-yards are completely are in the shadows in the morning and afternoon and always a part of the building make shadows on the court-yard floor and the opposite walls (Vakilinezhad et al., 2013) (Figure 2).

Table 2: Plan and Court-Yard Shape of Residential Houses in Qom City			
Row	Houses of Qom City	Plan and Ron Shape (Direction)	Court-yard Shape
1	Haj Ali Khan Zand House	 شمال غرب - جنوب شرق (رون اصفهان)	 شمال غرب - جنوب شرق (رون اصفهان)
2	Haj Qoli Khan Zand House	 شمال غرب - جنوب شرق (رون اصفهان)	 شمال غرب - جنوب شرق (رون اصفهان)
3	Yazdan Panah House	 شرقی - غربی (رون کرمان)	 شرقی - غربی (رون کرمان)
4	Shakeri House	 شمال شرق - جنوب غرب (رون راسته)	 شمال شرق - جنوب غرب (رون راسته)
5	Mirza Mohammad Baqer Rouhani House	 شمال غرب - جنوب شرق (رون اصفهان)	 شمال غرب - جنوب شرق (رون اصفهان)

6.3. The Building Orientation

One of the most important ways in establishing construction and its effect on the life comfort, which is closely related to the rotation of the sun and its radiation in different seasons, is the observance of orientation (Kasmayi, 2005).

These orientations, also called Ron, are divided into three categories, including: 1 – Rasteh Ron, 2 – Esfahani Ron, 3 – Kermani Ron (Pirnia, 2005).

6.4. Waterfall and Pond

In hot and dry climate, water evaporation can also reduce the air temperature (Dekay et al., 2007). Cooling by evaporation can contribute to thermal comfort outside the building and also reduces the thermal load of the building by reducing the temperature. This increases the amount of cool air that is sent into the building and makes natural ventilation more optimal and efficient (Watson and Labs, 2012).

6.5. Basement (Cellar)

The cellar is the basement that is lower than the level of the court-yard and we will reach it by stairs from the court-yard. In hot seasons, the temperature of the cellar is lower than the temperature of other parts because it is in the basement. (Qobadian, 2005).

Table 3: Sustainable Architecture Indicators in Residential Houses of Qom City

Row	House	Court-Yard Shape	Basement	Cistern	Windward	Main Material	Winter Stay	Summer Stay
1	Haj Ali Khan Zand House	Central	*	*	1	Brick	North side	East side
2	Haj Qoli Khan Zand House	U	*	*	2	Brick	North side	South side
3	Yazdan Panah House	Central & U	*	*	1	Brick	North side	South side
4	Shakeri House	U	*	Have not	Have not	Brick	Northwestern side	Southwestern side
5	Mirza Mohammad Baqer Rouhani House	L	*	Have not	1	Brick	South side	Southwestern side

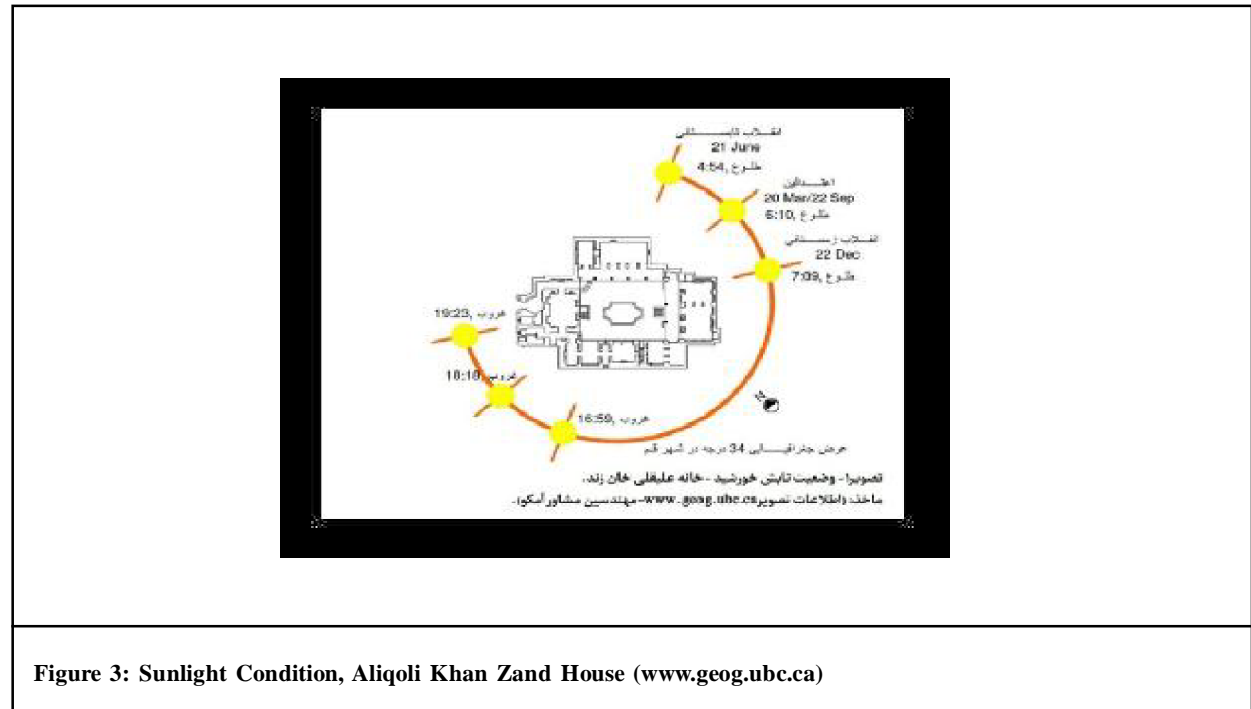


Figure 3: Sunlight Condition, Aliqoli Khan Zand House (www.geog.ubc.ca)

6.6. Windward

In many desert areas of Iran, cool air passing from the roof was received using of windwards and in accordance with the local winds direction change (Farrokhyar, 2009) (Figure 3). A windward is an architectural element with a climatic function that is a part of the buildings body in hot, dry and humid regions of Iran. Dividing interior spaces of the windward, makes Simultaneous entry and exit of air to the house space through separate ducts.

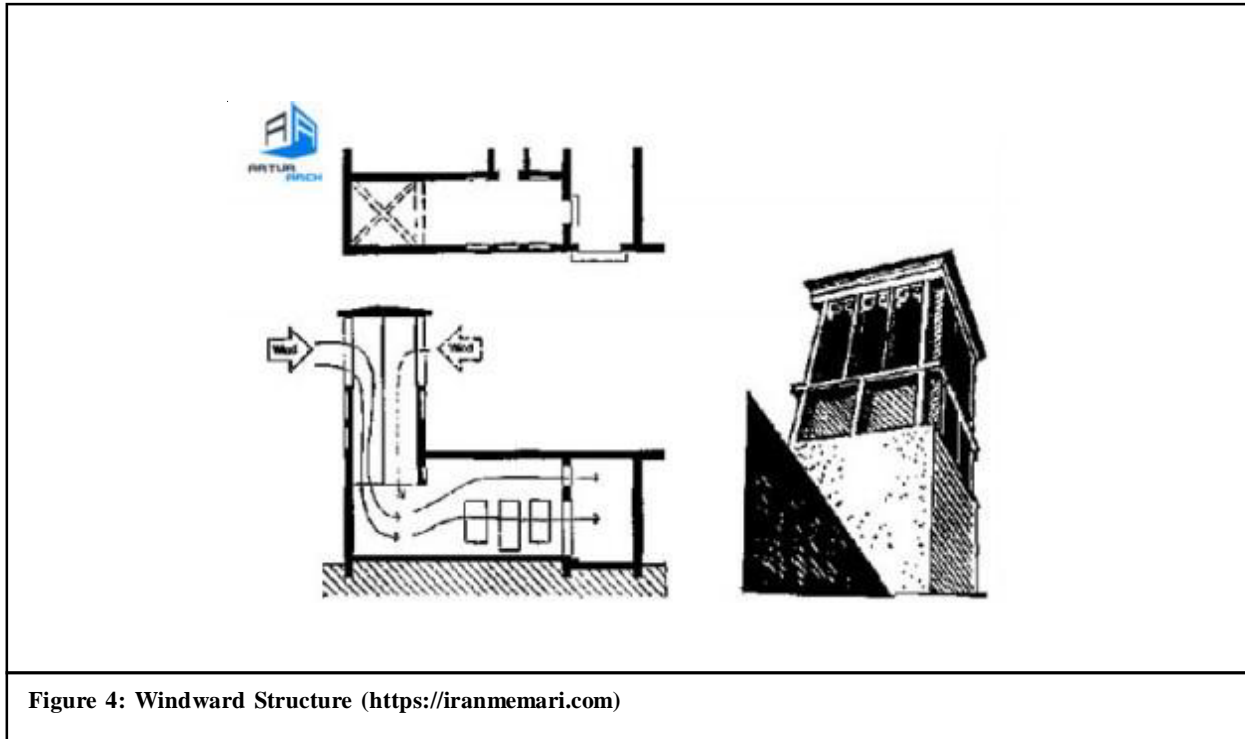


Figure 4: Windward Structure (<https://iranmemari.com>)

As a result of the chimney feature, windward enables to suck the hot air of the inside space of the building (Khasei, 2009).

6.7. Materials

Brick is the main material in the houses of Qom city and using of brick has a long history in the old tissue of Qom city. On the other hand, brick has been used in Qom city because of high heat resistance, sunlight reflection and high resistance to environmental factors in this climate.

6.8. Cistern

A cistern supplies water to the houses in hot and dry climates. In other hand, it cools the incoming hot air flow of the windward and stylizes that and as a result helps in cooling of the houses spaces air.

7. Conclusion

The court-yard is one of the most important elements in sustainability of these houses, the court-yard shape is mostly U with rooms and other spaces around it. Because of sunlight angle and intense heat, the placement of spaces around the court-yard creates an enclosed space that makes shadows in the hot seasons and the presence of the pond and green space inside it help cooling and stylizing the air of these houses. In other hand, the presence of a basement is one of the essential spaces in these houses, because due to locating the walls near the soil, the basement space in these houses is also the best place to escape from the heat of this climate.

Another important element in these houses are windward, which the air flow in the spaces of these houses acts like a water cooler and provides comfort to occupants by passing the dominant wind through their inlet and in some houses by passing it through the cistern under the windbreaks.

The spaces in these houses are divided into two main parts, summer stay and winter stay, which according to Figure 1 that shows the sunlight condition in this climate, the summer stay space is mostly located on the east and south sides to avoid the intense sunlight and its heat. In other hand, the winter stay space or royal stay space is mostly located on the north side to get the most of sunlight and its heat in the cold seasons.

Buildings in hot and dry regions are built with materials like brick, clay and mud that have a high heat capacity. Due to the difference between day and night temperatures, these materials store heat during the day and then transfer it to the environment during the night that weather is cold. Therefore, brick is the main material in these houses.

According to one of the important features to achieve sustainable buildings is to increase energy efficiency in various ways, including using of natural and clean energy like solar and wind energy, not using of thermal and sound insulation and using of local materials.

After reviewing case studies of Qajar period houses in Qom city, it was observed that in order to achieve a sustainable architecture, the most utilization of natural and environmental factors has been considered in these houses designing.

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