

Sabat is a stable and effective thermal element in the native architecture of hot and dry regions of Iran (a case study of Yazd)



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ABSTRACT

Iran is a large country with climatic diversity. Despite construction constraints, spaces have provided environmental conditions by relying on the indigenous architecture of each region. The hot and dry climate is the widest climate in Iran in terms of occupation that has climatic characteristics of dehydration, extreme heat in summer with sandstorms at certain times of the year, and winds in different directions as well as severe cold in winter. Several solutions have been used in designing open spaces and sidewalks in desert cities and have provided the possibility of a safe, comfortable and stable life for thousands of years despite the harsh environmental conditions of these areas. Sabat is among the solutions.

Sabat is one of the symbols of the desert city and is known as a structure of the elements of Iranian native architecture. This element has always been introduced in Iranian architectural sources as a practical element of architecture in the central and southern regions of Iran, especially in desert cities such as Kerman, Yazd, Isfahan, Khuzestan, and Kashan.

This element has many advantages. It reduces energy consumption, uses regional materials, and provides a cheap solution to employ particular spaces and be flexible to the climatic conditions. It provides thermal comfort and optimal use of natural energy in sustainable urban development. Sabat is a versatile element in Iranian-Islamic architecture. The main application of which is expressed as a shade and protects people from heat and cold. Different aspects of architecture, climate, structure, urban planning, sustainable social life, and urban security of Sabat are addressed in this article.

The main purpose of this article is to introduce the functions and features of Sabat in the cities of Kashan, Yazd, Kerman, Isfahan, and Khuzestan, presented in the literature. In the present study, more precise parameters are applied to the old and contemporary Sabat in Yazd alongside energy simulation of an example of Yazd Sabat in the Builder Design simulation program

The research work in this study is performed by employing library resources, local research, quantitative data, and a design-builder simulation program.

Keywords: Sabat - Thermal comfort - Stable urban space - Energy simulation -Hot and dry climate

1 INTRODUCTION

Ancient Iran is the base of art, architecture, and urban planning. Architecture has always and everywhere been art related to people's lives. Iranian architecture has been populist and has always considered human needs and desires. As a result, the design spaces and architectural elements were designed to make human life better. One of the aspects of the architectural design of past spaces has been designed based on environmental and climatic conditions.(1)

Sabats are also indoor and bridge-like paths inside cities that are designed based on human biological needs and play a role in improving human living conditions and comfort. Passers-by in

hot and dry climates and deserts, after passing through winding alleys and the oppressive heat of summer, reach a semi-open space with a roof, breathe new life. This multi-component designed element has now been forgotten in the design of our urban spaces due to its lack of recognition, and the sabats that are relics of the past have been destroyed or left alone. By recognizing sabats in hot and dry climates, a wider knowledge of them can be achieved and they can be used in designing urban spaces today (2).

The elements covering these passages are of two types, the first type is constructed in the form of single arcs or connections between two passages. These arches have no use and do not provide continuous and tunnel-like cover for the passage; Rather, there are simple braces to control the thrust of the forces on both sides of the passage wall. The role of these arches is purely structural and due to their structure, they can be called Tavize (figure 1).

The second type that is the subject of this article is Sabat; Which acts as a bridge-covering over the passages (Figure 2).

Sabat has had many functional values in the fields of climate, structural, social, and even defense. In this study, we study the Sabats in the historical context of different climates of Iran and specifically the Sabats in the city of Yazd and their impact on the climatic conditions of their surroundings by simulating the Sabat of Tabriz from the historical context of Yazd.



Figure 1: Tavize

Figure 2: Sabat

PARAGRAPHS AND HEADING HIERARCHY

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2 Iran Climate

Iran has a hot and dry climate that is characterized by long, hot, and dry summers and short and cold winters. January is the coldest month, with temperatures ranging from 5 to 10 ° C, and August is the coldest month, with temperatures ranging from 20 to 30 ° C or higher.

In most areas, summers are hot to hot with almost constant sunshine, but high humidity is in the southern coastal areas of the Persian Gulf. The daily temperature can be very hot. On some days the temperature easily reaches 40 degrees Celsius or more, especially on the shores of the Persian Gulf and the Sea of Oman, which carries the risk of overheating. About 70% of the average rainfall in the country occurs in November.

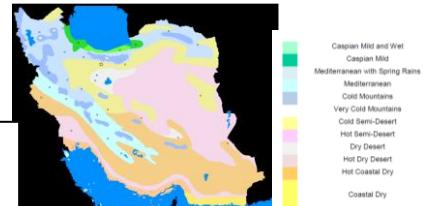
2.1 The hot and dry climate of Iran

In this investigation, it was intended to perform a case study in Yazd. Yazd is located at 31.8948 ° N 54.3570 ° E, 1200 m above sea level. The location of this region is demonstrated in figure 3. This city is located in the hot and dry climate of Iran. Prolonged dry heat and intense temperature difference between winter and summer and the intense difference between the day and night temperatures are the climatic features of this region (3).

Figure 3: Location of Yazd Province on the map of Iran



Figure 4. Climate Map of Iran



3. Sabat

3.1 The concept of sabat and construction factors

Sabat in the Persian language has ancient roots. The first part (Sa) means comfort and the second part (bat) means settlement and mansion. Sabat to all buildings that were erected for comfort, both in the city and outside the city (4). What is brought in this research from Sabat is the coverings and elements of the bridge, which is on narrow passages and urban passages that are mostly used to improve human living conditions in hot and dry climates. The main purpose of designing this element was to pay attention to human needs and to organize the human living conditions of that time. One of the most important spatial functions of Sabat is to create shade by a roofed and semi-open space that creates maximum shade on the ground, which can be observed in urban areas of these areas, creating air blinds and temperature differences (5) adjusting environmental conditions, He mentioned the creation of an air circulation tunnel, sitting and resting inside it .Due to its semi-covered structure, this structure leads to the formation of air blinds in summer, which cools the air inside Sabat from the outside. And this half-covering in winter made the air inside Sabat warmer than outside. Sabat is also a means of counteracting the monsoon winds. According to the above definitions, it can be concluded that the main function of sabats as a climatic element is to prevent direct sunlight and protect against monsoon winds, and also as a structural element to strengthen the building and prevent The drift of the walls has been considered (6).

3.2 The main reason for making sabats in hot and dry climates

In this definition, the main reason for making sabats is the angle of vertical and direct sunlight, especially in hot seasons in these areas, and also the problem of monsoon winds with dust and fine desert sands that are neutralized by sabats. To be. Sabbaths are a type of fixed canopy that is fixed in all seasons. Therefore, their efficiency in terms of creating shade and comfort points depends on daily and annual changes in the position of the sun (Figure 5). It has become collective in urban neighborhoods and social stability in urban neighborhoods and therefore is compatible with the criteria of a sustainable city (7).

In Figure 6, a small part of the old neighborhoods of Yazd (Golchinan) where Sabat Tabrizian is also in this area, the number of Sabat and Tavize that are located are shown in red, which are very organically formed, and a large number of these elements strength and stability. Shows the city.

Figure 6: Aerial photo of a part of the historical region of Yazd and the impact of Sabat on the stability of the city



Figure5



3.3 Features of Sabat

- 1- Adjusting environmental conditions and providing comfort conditions: Sabats on urban spaces and passages, by creating shadows and tolerance, elevate human beings against the environmental conditions and hot and dry climate of the region, and create air blinds (8) in The traditional architecture of desert areas Alleys are often narrow and have several turns

that reduce the speed of cold winds, and in the meantime, the presence of the element Sabat has also come to the aid of this climatic architecture. Until the cold winds that enter the passageways collide with the obstacle that is the wall of Sabat in its upper layers and the wind speed decreases (6).

- 2- Structural role: Due to the issue of privacy and introversion of Iranian houses, high perimeter walls are built, but due to material savings, the walls of historic buildings are generally designed to be narrow and narrow, resulting in double side forces. Sabat helps to compensate for the small thickness of the brick walls to a considerable extent and prevents them from falling, and increases the building's resistance to any horizontal force caused by earthquakes, wind, etc. (9)
- 3- Creating a sense of neighborhood: The part of urban spaces that were created from the construction of Sabat due to confinement, roofing, and difference in height with the general space of the passage became a center for gathering residents or the entrance space to one or more houses (10)
- 4- Causing space shock and pausing in space (4)
- 5- More privacy in some buildings: In some dead-end alleys, Sabat is also implemented, in the entrance of which a solid door was installed, which was suitable for increasing the security of the residents of the alley. This type of space is called "Darband"
- 6- Sabat social structure: In the past, Sabat was a place for gatherings of neighborhood residents, and these gatherings have made the people of the neighborhood aware of each other's situation and understand each other's problems, and thus solve problems with each other's help. In new urban planning, Sabat may no longer have such a place and the volume may seem useless, but Sabat is an advantage and a virtue that has been forgotten (4).
- 7- Sabats and Defense: The Sabbaths, due to their proportions and height, were a deterrent against the attack of the enemy riders (11).

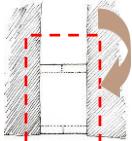
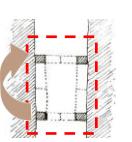
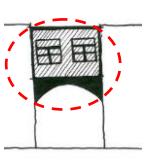
Formology	Description		Types and samples	Plans and views
Type of cover	Cover Continuous	Sabats covered with barrel vault		
		Sabats covered with Sharp vault		
		Chamber sabats The right size eyes to the alley personal use		

Table 1- Formatology of Iranian sabats

4. Sabbats of hot regions of Iran (Khuzestan-Kashan-Isfahan-Kerman-Yazd) **Khuzestan**

Due to the high heat and humidity, how establishing buildings and special architectural elements in this city are a way to create comfort.

Due to the humidity in this area, it was made of bricks or drilled by hand.

- Sabat Kazem Lami: The orientation of Sabat Lami, like most of Sabat in Dezful, is northeast, southwest, perhaps due to the prevailing winds in the warm months of the year, which are to the west and southwest. (12)

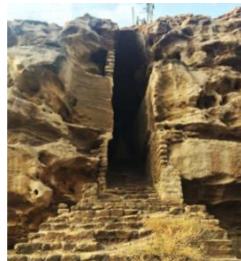


Figure 8: Sabat input



Figure 7: Sabat Kazem Lami

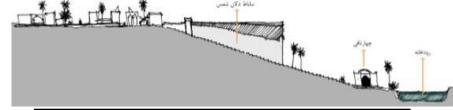


Figure 9: Sabat Dokan Shams location

• Sabat Dokan Shams

At the beginning of entering Sabat, we encounter a large number of hand-made stone steps that lead us surprisingly down and adjacent to the river (Gargar River). This stepped path ends with an old building that belongs to the Sassanid period and had the function of a fire temple. This sabat has been drilled by hand in the heart of the rocks of the Gargar river (13).

Kashan-Isfahan-Kerman-Yazd

Due to the close climatic similarities of these 4 cities, it can be said that similar sabats and similar materials have been used, and due to the low humidity, more clay and thatch have been used.



Figure 11: Isfahan



Figure 12: Kashan



Figure 13: Kerman

5. Architecture of Yazd city

The old texture in these areas is dense and arose from the connection of buildings around narrow and irregular alleys. The urban space is also completely enclosed and the establishment of biological complexes is determined based on the direction of the sun and wind. The following reasons have been effective in shaping the contemporary texture of buildings as described:

- Protecting urban spaces, passages, yards, and buildings against atmospheric factors, especially adverse winds with the help of dense texture
- Reduce the speed of desert winds with the help of winding alleys and reduce their destructive effect.
- Providing the possibility of creating shade on all surfaces of narrow alleys with the help of high walls around the passages.
- Reducing the contact surface of residential spaces with hot air outside (7).

6. Sabat typology in Yazd (type of arch)

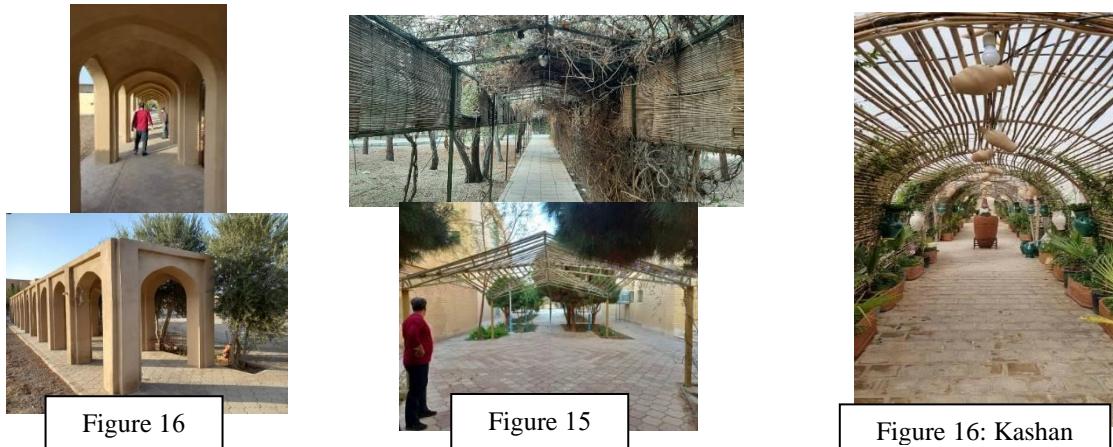
Arches have always existed in the history of architecture with two general shapes round and pointed arches. Other shapes are usually a combination of these two shapes.

7. Sabat Contemporary

Due to the hot climate of Yazd and the scorching sun in Yazd University, which is a relatively large site, an attempt has been made to use it for the busy roads of students and to create the thermal comfort of Sabat, which is a model of local architecture.

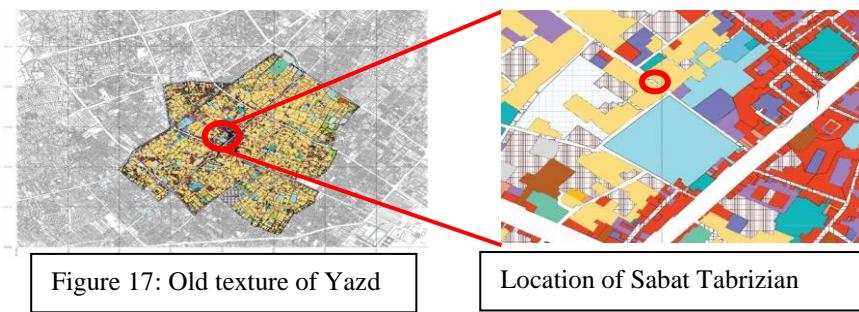
These sabats are divided into two types:

1. Sabat is made of clay and mud: which is made using the same local materials and old construction techniques, and bypassing it, in addition to being protected from the sun's radiation and heat, it has revived the architecture of the past. (Figure 16)
2. Sabat with native trees of the region: By closing the scaffolding in the traffic route and covering its roof with native plants and trees of the region, it is a cheap and effective method (Figure 15).



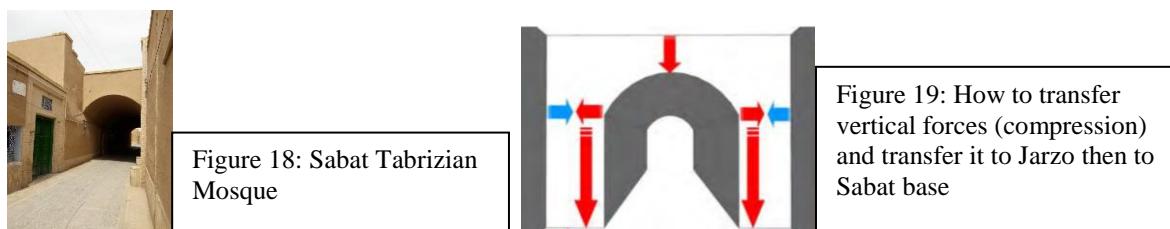
8. Sabat Tabrizian Mosque (a case study of Yazd)

The studied Sabat is located in Yazd city, Ghiyam Street and Golchinan Alley. This alley has three Sabats, which we will study in Tabriz Sabat.



8.1 Structural analysis of Sabat Tabrizian Mosque in Yazd

Analysis of vertical and horizontal forces on the arch and their transfer to the foundation
 Gravitational force (compression) in this sabbat is applied to the arch of the arch applied to the two clean sides of the force. This force is applied in two directions of the horizon and perpendicular to the relative wall, which is broken down by the vertical force and then transferred to the ground.
 The thrust force also enters the clean side in the direction of the horizon and tries to destroy the cleaner, which is neutralized by the reaction of the thrust force that enters the relative wall from the adjacent arch. This sample (arch) produces less force in terms of compressive and thrust load. (11)



8.2 Simulation of a sample to evaluate its comfort conditions in hot and cold seasons

In this section, we examine Sabat Tabrizian Yazd and express the results of its simulation in Design Builder software.

This simulation was performed on a summer day (July 15) and as the figures show, the wind speed is 6.45 m / s and its direction is northwest. This wind enters Sabat from the southwest with a flow rate of 4681.33 l / s (Figures 20 and 21) and from the northeast with A flow rate of 1 / s4598.04 leaves Sabat (Figures. 20 and 22).

As it is known, Sabat reduces the wind speed and controls the wind, and it can be concluded that Sabat has more favorable conditions than the surrounding spaces when the wind blows at high speed.

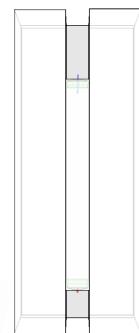


Figure 20

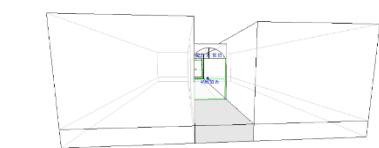


Figure 21

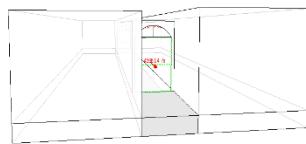


Figure 22

- Simulation and investigation of airflow in Sabat on a summer day**

As shown in Figures 23 and 24, on a summer day, the highest airflow is near the roof of Sabat and the lowest is in the middle of Sabat and near the ground, which is a place for pedestrians.

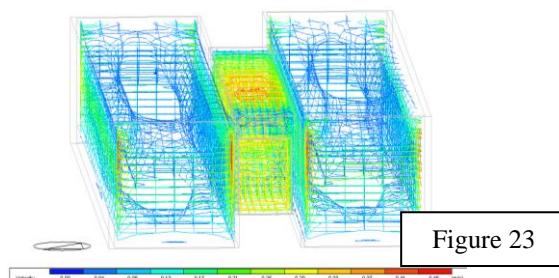


Figure 23

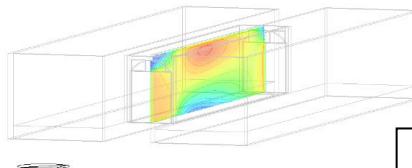


Figure 24

- Simulation and investigation of airflow in Sabat on a winter day**

As shown in Figures 25, and26, on a winter day, the lowest airflow is near the roof of Sabat and the highest amount is near the ground and the place for pedestrians.

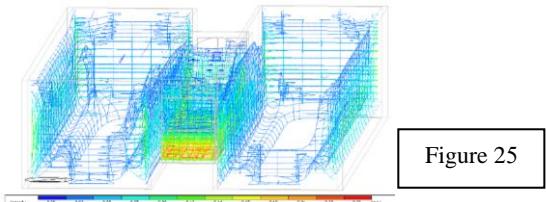


Figure 25

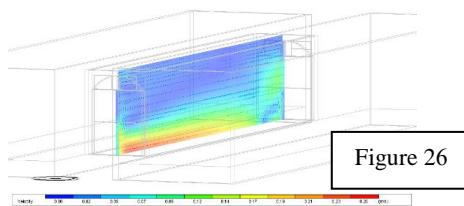


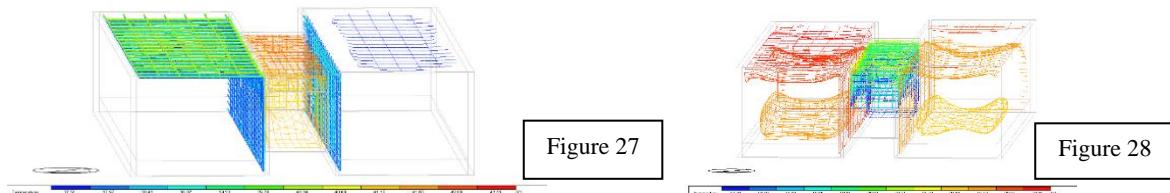
Figure 26

- Simulation and investigation of Sabat's internal temperature on a summer day**

As shown in Figure 27, the temperature of Sabat in the middle of it decreases by 1-2 degrees Celsius compared to its inlets and creates more favorable conditions than the open spaces around it.

- **Simulation and investigation of Sabat's internal temperature on a winter day**

As you can see in Figure 28, the temperature of Sabat near the entrances on a winter day is higher than the average temperature of Sabat.



9. CONCLUSION

Sabat has been introduced as a structure with the main function of sunshade and windbreaks unique to Iran's central and southern regions and is one of the architectural features of desert areas of Iran.

By simulating a Sabat sample, it was found that in Sabat, the velocity of the output current from the inlet is lower, which can be concluded that it reduces the wind speed, and the back-to-air space in Sabat has a smoother airflow than the wind-facing space and reduces The wind blows

The internal temperature of Sabat is lower than the surrounding environment in summer and winter, which has caused the presence of Sabat in the streets on hot summer days and shading, providing a cool environment for pedestrians.

This indicates that Sabat is a sustainable architectural space for the city, which in addition to thermal comfort has its stability and resistance to natural and unnatural factors. For this purpose, an attempt was made to gain a deeper understanding of Sabat by mentioning the example to increase its better understanding. Although these techniques are obsolete or less considered today due to modern technology in the urban planning and construction industry, so proper modeling of them can be the right way in urban planning, reconstruction, and restoration of various arches in historical buildings.

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