Investigation and Analysis of Historical Bridges in Hot and Humid Areas with Agricultural Use Based on the Comparative Study of Khuzestan and Bushehr Bridges

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Abstract
Throughout history, road and road construction has been one of the hallmarks of the flourishing of civilizations, and bridge construction has been a function of the progress and prosperity of road construction. Bridge construction has flourished as more connections between cities and malls have been established. Bridges built in hot and humid areas are one of the reasons for Iran's geopolitical, social and Sassanid position, especially during the Sassanid and Safavid periods. This architectural structure plays an important role in the growth and flourishing of culture, economy, politics and military power in the region. ; Therefore, the study and identification of this structure alone requires special research and study. This research aims to, in addition to better understanding and understanding of architecture, the art of building bridges in these hot and humid areas, the importance of the position and role of this structure and the need to build it in everyday life. The research is based on comparative studies and has been done by descriptive-analytical method. The results show that what has made Khursestan and Bushehr bridges valuable is the view that human beings have on foot; A person who walks, thinks and watches, listens, relaxes and has fun. The body of the bridges has met all these needs and provided suitable conditions for their emergence.
Keywords: Historic bridge, climate, hot and humid, Khorestan, Bushehr

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Introduction

The vast land of Iran is a high plateau with many lows and highs, the existence of these lows and highs has caused climate diversity; In this way, the amount of rainfall in the north and west areas is relatively abundant and very little in the central part. Despite this, Iran has a vast network of flowing waters, both in the form of permanent rivers and in the form of temporary rivers. Rivers were considered great obstacles on caravan routes; Therefore, for road construction, the need to build a bridge was strongly felt.

One of the human problems is the existence of natural obstacles, especially large rivers, which interfered with various political, cultural, commercial and economic communications, and with the construction of bridges, these obstacles were reduced to a large extent.

Bridges and dams are non-religious and public buildings that have been built on rivers and along caravan roads since long ago. In the construction of bridges, Iranian architects, in addition to facilitating the passage, have also considered the creation of dams and water storage (Pirnia, 2011).

Because of the important role they play in creating, maintaining and expanding communication, bridges have been greatly welcomed by human societies from the very beginning. The construction of bridges has made it possible for humans to communicate with more lands. In prehistoric times, due to the limitations of communication, simple solutions such as traveling in the dry season using a boat and building a wooden bridge have been used for transportation. The shape of the early bridges and their materials were much simpler. Most of these bridges were made of wood. But with the formation of governments and the expansion of commercial and cultural communications, military invasions and the advancement of architectural techniques, bridges became a special place for the art of architects and their builders.

Historical bridges are a valuable heritage whose protection is important from the aspect of cultural continuity. Placing a bridge in a waterway changes the flow profile. Most of these changes come from the geometrical details of the bridge. Semicircular and chevron arches are used in the architecture of historical bridge spans (Khayat-Rostami and Hasanzadeh, 2012).Among the important historical bridges is the Latidan bridge in Bohesher province, which has attracted the attention of architectural researchers due to the greatness and splendor of this bridge. In Khuzestan, the old bridge of Dezful and the bridges of Shushtar have given a special historical and tourist aspect to Shushtar. The bridges of Shushtar and Dezful are huge structures with all the similarities that belong to the same period of time, they have multi-purpose functions, and for this reason, they have been renovated many times (Enaiti, 2014).

Research Methods

This research is fundamental applied in terms of approach and descriptive analytical in terms of method. Information has been collected through library sources and field observations. In this way, based on the comparative study of the collected information (which is mostly qualitative), the bridge building of Khuzestan and Bushehr region is examined based on historical precedence.

- Theoretical foundations of research, concepts and definitions

The emergence of the bridge in Iran

The bridge, like other works of architecture, has been considered as an effective communication factor since the past, and the practicality of the bridge has caused less attention to be paid to its environmental aspect and natural background. Bridges built in different parts of Iran have different practical aspects. But sometimes we will understand a combination of these functions in the construction and design of the bridge (Nejad Ebrahimi et al., 2017). Before the emergence

and expansion of the construction of bridges, the existence of natural obstacles, especially large rivers, in the path of various cultural, commercial, political and Economic, it was one of the major and fundamental problems of human life and an obstacle to the development and expansion of human civilization. It was with the construction of bridges that this problem was solved to some extent (Meshkini Asal, 2010: 291). It seems that in the later stages, man used past experiences and thought of such a solution to cross wide and shallow rivers or canals, that during water shortage, he built a support in the middle of it and the trunks of tall trees. place on both sides of this beach and this support and thereby solve the problem of passage in these cases (Farshad, 1975: 356).

The emergence of the bridge in Iran

In today's land of Iran, the oldest bridge whose traces are left is the bridge built by the Orators on the Aras River, although this bridge was destroyed around the 8th century BC, there are still enough traces of it to be able to He realized the existence of the bridge and its design and size.

From the Achaemenid period, a relief bridge was found in the area of Pasargad palaces and gardens, which were built in the 5th and 4th centuries BC. No traces of Parthian period bridges have been found, but the existence of the Silk Road, which passed through the heart of this empire, could not have existed without bridges. Perhaps, in the future archaeological excavations, traces of the bridges of this period will be found (Meshkini Asl, 2010).

The necessary conditions of the Sasanian period required that bridge building be considered like other architectural activities; As the bridges built in this period are considered masterpieces in their own way. Considering the continuity of Sassanid period architecture in the Islamic period, the dating of Sassanid period bridges should be done with extreme caution. During the Seljuq period, according to Ibn Balkhi's writings, princes and governors attached great importance to the construction and repair of the bridge.

During the patriarchal period, the construction of bridges and roads continued. The Timurid period is considered one of the most important periods in Iranian architecture. From this period, there is a wonderful example (Pol Dokhtar Mianeh) that shows great knowledge and skill in the field of bridge building (Dioj Poli, 2014).

During the Safavid era, due to the expansion of the road network and the great luck that was directed towards architecture, bridge building enjoyed significant progress. In any period of Iran's history, from the Islamic era to the Safavid period, road construction and related buildings have not expanded as much as during the Safavid era, and most of the bridges that can be seen today in the corners of this vast land are among the valuable works of this period. attributed to it.

During the Afshariya period, not much attention was paid to the construction of roads and bridges. But from the Zandiyeh period, more or less, important works of the bridges of this period have been remembered.

In contrast to the advanced architecture of bridges in the Safavid period, some old bridges were restored during the Qajar period, and a relatively large number of bridges were built only for the convenience of traffic.

In the Sassanid era, one of the most important periods of bridge building in Iran was formed with a great evolution in arching techniques that occurred simultaneously with a long period of peace and prosperity of civilization. They are completely healthy, apart from these, there are still some bridges that were built on the foundations of Sassanid bridges in later periods. One of the most important bridges of this period is Dokhtar bridge in Lorestan province on Karkheh.

After Islam, until the 4th century, bridge building was practically under the influence of Sassanid techniques and methods, and despite the presence of very large and spectacular bridges, there was no special innovation in it. Kalher Bridge and Keshkan Bridge in Lorestan province are one of the most important bridges of this period. During this period, an important part of the Sassanid bridges were restored. including the Gaomishan bridge in Ilam (Persi, 2006).

Perhaps the Seljuk dynasty is the most important empire based in the Iranian plateau after the Sassanids. Although all written sources mention the prosperity of roads and big bridges in this period, today few of these bridges remain. Khoda Afrid Bridge on Aras, near the Safavid Bridge of the same name, and Tous Bridge in Khorasan are among the bridges of this period. Perhaps the Mongol attack is one of the reasons why the bridges of this period did not remain, although it seems unlikely that the Mongols simply destroyed the works of this period. From the Ilkhanate and Timurid periods, despite all the destruction, some bridges have been left. Among them, Ba Ba Mahmoud bridge in Flowerjan (Ilkhani period) and Dokhtar Mianeh bridge (Timur period) may be an important part of the bridges of the Safavid period, the result of extensive reconstructions of the bridges of this period. The Safavid period with 143 bridges is the most brilliant period of bridge building in Iran.

It is natural in the prosperous roads where nearly a thousand caravanserais were built next to them. A large number of bridges were also needed. Fortunately, the strength and precision in the construction of these bridges and their shorter time interval compared to today, have caused the bridges of this period to remain intact. Perhaps the most important event of this period is the appearance of urban bridges, whose exceptional examples in Isfahan are considered masterpieces of bridge building and architecture. The importance of these bridges is not only because they are located in the center of the city, but also because they are used as an urban space, because a bridge is simply a way for There is no crossing of the river and by building promenades inside and under the bridges, instead of keeping people away from the water, they have made it possible to access and enjoy the movement of Zayandeh Rood Raham. Due to the short period of Zandiyeh and Afshariya. Many bridges from this period are not left, five bridges from Zandiyeh and one bridge from Afsharta period have been identified today, including: Khatun bridge on Khoy Selmas road from Zandiyeh period and Kalat bridge in Kalat Naderi from Afshariya period. Qajar period is one of the important periods of architecture. Irani is also a very important period in terms of bridge building. There are five bridges from the Qajar period left behind in Mehran, the river is seasonal, and of course there is no bridge-building tradition in Isfahan. However, they are very beautiful. The three bridges of Zanjan, including Mir Bahauddin, Haj Syed Mohammad and Sardar, are excellent examples of bridge construction along the roads

outside the city. Most of the urban bridges, even corridors-rooms had spaces that are made only for stopping and enjoying. The Allahwardi Khan bridge or the thirty-three bridge and the Khawaja bridge are excellent examples, and the Qari bridge in Tabriz is one of the last examples of this type of bridge construction. Urban bridges were built horizontally and usually with a number of spans of the same size and shape and had decorations.

The out-of-town bridges functioned according to the topography of the place. Therefore, they did not necessarily have equal openings, often the largest amount of water passed under the middle opening, which was larger. In some cases, depending on the shape of the river, one of the side openings was the largest opening. This problem has affected the shape of the bridge, and because the arch of the arch is bigger, it has more lift. These bridges are not horizontal and their surface is sloped. In cases where the side opening is larger. The bridge loses its symmetrical shape.

Bridge applications

The bridge plays an important role for mankind in order to expand and create connections and provides a possibility for mankind to connect to other lands. Based on this important role, bridges were built in rivers, canals and caravansary roads. In addition to the communication role of the bridge, other advantages can be listed for it.

A - Since the Achaemenid period, many bridges have had the dual function of a bridge and a dam. In this way, water was stored for times of water shortage. Also, these bridges and dams used to divide the water and a part of the river water was sent to the areas that did not have access to water.

B- Next to and under many bridges, they built water mills and used the flow of water to turn the millstone.

C - Bridges have been a good place to control roads and convoys, and there have often been guard stations on bridges, and in addition, tolls and tolls have been collected on bridges.

D- Inside the city center, the bridges are a place for people to gather and have fun and trade.

e- In addition to economic, political, social issues, these bridges also had a strategic and decisive role in military issues; Manzouz sent equipment and supplies and besieging bridges played an important role in conquering cities and conquering the country, that's why bridges also functioned as a defensive fortress.

Bridge construction experiences before Safavid era

The bridges of the Achaemenid period with a different architectural structure have been able to attract the attention of researchers. One of the prominent examples related to the Achaemenid period is the Kalhor Bridge, which has been able to provide empty spaces in the body by using pointed arches (Farshidnik and Afhemi, 2009). Shadervan Bridge, which some mistakenly consider to be related to the Achaemenid period, its construction is related to the Sassanid Shapur I period, and in the examination of Shadervan Bridge, most of the characteristics of Sassanid bridges can be seen well. The most important characteristics of Sassanid period bridges can be found in the fact that their foundations are built on a wall that covers the width of the river well. In the Shadarvan bridge, all the materials related to the Sassanid period include saroj,

lime shaft and rubble, and in these bridges, there are usually iron, stone and lead parts (Enaiti, 2014). During the Sassanid era, many bridges were built using metal fasteners of carved stones. One of its outstanding examples is the Shushtar bridge, which is a combination of a bridge and a dam. Shushtar Bridge is similar to the Roman examples, whose central core is made of mortar and rough rubble, and the exterior of this core is covered with brickwork (Mohammadi et al., 2011).

The hot and humid climatic region of Iran is a narrow strip from the mouth of Arvand River in the southwest of Khuzestan province to Khilij Goatar in the southeast of Hormozgan province. In this area, the summers are relatively long and in the winters, the weather gets cold only in the two months of January and February. Although this coast is located next to the sea and the air humidity in these areas is very high, but due to low rainfall, it lacks vegetation and except for the limited groves and fields of the people of the region, it is generally barren and waterless. And it is grass (Qabadian, 2008: 68)

The hot and humid climate (southern coasts of Iran) has created special architectural features to deal with its conditions. This characteristic is relatively the same in all the cities that have this climate and live in the same region, and for this reason, it can be said that architecture in a climate shows its differences only in the parts related to culture. Here we discuss the impact of climatic factors on the architecture of Bushehr province to see what effects the climate has had on the architecture of this region.

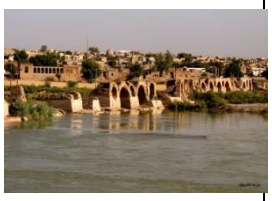
Features of native architecture of hot and humid areas: The native architecture of hot and humid areas has unique features, the use of building materials with low thermal capacity and placing the building in full shade here as well, wide and covered porches that They both prevent the penetration of rain and cast a complete shadow on the walls of the rooms. In areas close to the sea, large wind deflectors have been used to use the cool wires of the sea. In these areas, due to the high temperature and humidity of the air, the amount of natural ventilation is not very important and the texture of the houses in this area is dense (Kasmai, 2002: 85-95). It is densely expressed and relatively open rural texture and semi-enclosed urban spaces and the expansion of coastal cities and villages along the coast and facing the sea (Qabadian, 2008: 70), creating shade and penetration of minimal solar radiation and heat into the building and The use of natural air flow and the use of prevailing winds and local breezes and paying attention to local morphology such as proximity to water bodies and plants are other characteristics of these areas (Nikghadam, 2011).

Buildings in different climates have special characteristics. In hot and humid climates, these characteristics are as follows:

1- In the topic of functions and spatial relationships, by examining their details, it has been observed that most of the buildings have rectangular plates and the rooms have three doors and five doors, which has caused air conditioning in the past.

2- Here, the absence of a dividing space (hall) in residential houses has caused that all spaces are directly connected to the courtyard.

3- Most of the rooms are dimly lit, and most of the openings, including doors and windows, are used for ventilation. Above the windows, you can sometimes see lattices decorated with colored glass, which the residents use to create light shadows. They use, which of course today is filled with plaster due to the accumulation of banana insects.
4- Due to the high heat of the air, most of the windows are small in width and high in height, because the passage of air flow is prioritized over the net.
5- The main location of windows, especially in rural areas, is at a height of 20 to 30 cm from the ground, because it causes the flow of dry air to be drawn from the bottom to the inside, and the flow of warm air to the outside from the top of the window. to find
6- The ceilings are mostly high because the hot air flow is placed in the upper part of the room and according to the standard height of a human being, it should not be placed in this space.
7- Chinese chairs are used in most of the buildings. This Chinese seat is higher than the level of the yard. This is important.
A- It prevents the penetration of moisture into the walls and floor of the building. Not. This seat is also located in the main facade of the building, which is called platform, and when the weather is good, they use it for sleeping at night. P. It is worth mentioning that despite the presence of Chinese chairs in some houses, it has been seen that the walls are damp in the lower part, or due to high humidity, the paint has come on the walls.
8- The length of the buildings is mostly in the east-west direction and the second degree is the north-south direction.
9- The main front of the living area (mostly inhabited) in most of the houses is primarily facing south and secondly facing west.
10-Unlike other climates, this choice and orientation is not related to the angle of the sun, but the winds of the south-eastern front, the winds that cause the air to become cloudy. It is mainly towards the south and west. (Aminian et al., 2013: 209)
According to the mentioned cases, in order to make the buildings compatible with the hot and humid climate in contemporary designs in areas such as Bushehr province, which is the area studied in this research, it is possible to achieve goals such as: reducing the level of beta solar radiation and creating shadows. Dealing with direct sunlight into the peta, using bright colors in buildings, reducing heat conduction flow, increasing and creating air flow and movement inside the building, reducing the effects of favorable winds and proper use of vegetation, proper orientation towards Khurshid pointed out the location of refrigeration facilities and the use of materials with suitable thermal capacity (Amanian et al., 2013: 228).

Description	Materials	Width to length ratio	Decorations	Arc type	number of openings	Period	River	تصویر	Name Bridge	Region	Z
This bridge was built on the river in 260 AD by the order of Shapur Olassani. Later, the bridge was destroyed and the current bridge was built during the Safavid period, and repairs were made during the Qajar period. Also, the concrete parts of the bridge were added during the Pahlavi period.	The foundations and upper walls are made of stone and mortar, the foundations and deck of the bridge are made of bricks with mud, lime and mortar.	0.024	Railing with ordinary strapping made of Saroj mortar	sharp crossha irs	23	Sasani	River Dez		Dezful old bridge Sasanian) bridge-Roman (bridge	Khuzestan	1
Shadorvan Shushtar Bridge or Qaisar Dam This bridge is related to the Sassanid era and was built by Shapur II. Shadervan Shushtar Bridge is the oldest bridge in the world	Stone, brick and Saroj mortar	0.016	Railing with ordinary strapping made of Saroj mortar	sharp crossha irs	44	Sasani	Shatit River		Shadran (Kaiser (Band	Khuzestan	2
Lashkar Dam Bridge is one of the constructions of Shushtar Nizam Abyss, Lashkar Gate, one of the six historical gates of Shushtar, was next to this dam bridge, and traces of Shushtar's fence can still be seen next to this dam bridge. Returns.	Saroj sand, stone and mortar	0.028	No decoratio ns	Triang ular arch spicy	13	Sasani	Darion river		Lashkar bridge	Khuzestan	3
The purpose of building this Abro bridge, which is called Abareh, was to transfer water through the canal and bring it to the surrounding agricultural lands. which is called a breakwater or water (behind the bridge) in the form of a semicircle.	The foundations and upper walls are made of stone, the foundations are made of bricks with mud, lime and mortar.	0.013	Simple brickwor k with ordinary slats made of Saroj mortar	A five or seven type arch	12	Safavi	———		Sayha Bridge Abareh) Abbas (Khan	Khuzestan	4
Shah Ali Dam is located in the south of Shushtar and west of Imamzade Abdullah. The foundation of this bridge belongs to the Sassanid period and it was located outside the Lashkar Gate towards Ahvaz along with the Lashkar Bridge.	Bricks, crushed stones and rubble, Saroj mortar	0.352	Brick work on the surface of the arches with ordinary strapping made of Saroj material	Percuss ive bow and sharp crossbo w	3	Sasani	Darion river		Shah Ali Bridge	Khuzestan	5
This bridge is the biggest bridge of the Safavid era in Hormozgan province.	Saroj stone and mortar	0.005	No decoratio ns	Slow crossbo w	223	Safavi	Darion river		Latidan Bridge) Piggyback (	Hormozgan	6

This bridge is formed by arching on both sides by means of pointed arches built between the bases. The opening and the arches are due to the fact that the central opening of the bridge was built on the south side, for this reason two openings were built on the two larger sides, the south side and three openings .on the north side	Stone, brick and plaster agenda Long iron nails	0.101	The use of cut stones in the form of folded veins	Percussive and Roman arch	6	Sasani	Gharea ghaj river		Paul Moshir (Dalkey)	Busheh r	7

Result and Discussion

The historical bridges of Khuzestan and Bushehr are different in nature, but the similarities between these bridges and other bridges in the region can be observed. In this research, the examination of bridge-building experiences in Iran and the existing traditions in hot and dry regions, emphasis on Khuzestan and Bushehr bridges as a factor in the urban life of the people of Khorestan, and also the study of the adaptation of these examples (the historical bridges of Shahr-e-Loshahr and Zezful) to the knowledge of Mehjanm in terms of functionality, we found the constructions as influential bridges.

According to the examined features of the bridges, the creativity that existed before the historical and regional bridges, as well as the structure of the Iranian bridges, the many functions and the interrelated ways that the human presence and use of the bridge respond to different aspects of life, especially the need for entertainment, have caused the formation of bridges.

In Khuzestan province, due to the Haas climate and despite the rivers full of water, the construction of the bridge has been important both economically and in terms of communication. The technical issues of the complex construction of traditional bridges must withstand the constant erosion of water flow, raging floods and rolling stones. Local materials of the region have been used to build the bridges. Most of the foundations are made of stone and the bodies are made of bricks. Brick decorations have been used in most of the bridges. In this research, while describing the bridges of Khurzestan region as an example of hot and humid climate, the goals and applications of bridge construction have also been investigated and evaluated.

References

1. Hami, Ahmed (1992). water supply Tehran: Building and Housing Research Center.
2. Molazadeh, Kazmomohammadi, Maryam (1999). Encyclopaedia of Iran's Historical Buildings in the Islamic Period 4: Public buildings. Tehran: Islamic Propaganda Center, Art Center.
3. Farshidnik, Farzan Hovafhemi, Reza (2009). Plascontah is a complete continuity of the use of transit and residence in Iran's bridges. Journal of Art and Architecture and Urban Design, (41): 55-66

4. Moruj Torbati, Khatira, Pournadari Hossein, (2013), the study of the continuity of the effective traditions in the formation of the Khajojo bridge based on the study of the adaptation of the historical bridge of Isfahan, Bagh Nazz, 10th year, number 27.
5. Meshkini Asl, Reza, (2008), investigation and identification of bridges in West Azerbaijan during the Safavid and Qajar eras, Ehrir magazine, numbers 36 and 37
6. Khayat Rostami, B. Hasanzadeh, Y. (2013), Reviewing the history of water engineering in Ardabil region, the 5th Iran Water Resources Management Conference, Tehran.
7. Kordzanganeh, Fereshte, Kolah Kej, Zahra, (2014), the role of Roman architects in the construction of water structures of the Sassanid period based on the Shadarvan bridge. International Conference on Research in Science and Technology Engineering.
8. Nejadabrahimi, Ahad, Nazarzadeh Eranzodi, Elnaz, Nazarzadeh Eranzodi, Farnaz. Factors influencing the architecture of historical bridges in Iran in plain areas. Archaeological researches of Iran. No. 26, Volume 10, 118-97.
9. Mohammadi, Maryam, Nistani, Javad, Mousavi-Kohper, Seyed Mehdi, Hozhbari-Nobari, Alireza. 1390. Studying the typology, elements and components of Iranian architecture in the Sassanid period, Archeology Letters, No. 1, first period. 83-104.