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Original Research Article

Feature Retrieval of Khaju Bridge Architecture and Its Surrounding Landscape and Environment based on Visual and Descriptive Documents

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ABSTRACT

Historical bridges of Iran, as well as other artifacts of traditional societies, in addition to their function, are the place for the crystallization and transfer of implicit concepts in the worldview of its creators. Khaju Bridge had the role of a dam and was a strain among the most beautiful bridges of the Safavid era. For this reason, along with the Isfahan bridges, Khaju Bridge's structure is different from other bridges. This study attempts to answer the question of how was the construction of the Khaju Bridge at different times. The impetus behind the paper is to reconstruct the original structure of the Khaju Bridge based on data gathered from descriptive and visual documents in different periods and provide a general understanding of the Khaju Bridge from the beginning of its existence to the present time. This research analyzes the images and documents to find out the components of construction. This research was carried out using a comparative study method based on library and field studies. This research is the first attempt which reveal the original image of the Khaju Bridge and its form and shape over time.

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Introduction

Iran's architecture has not been disconnected from the traditions of its predecessors in any era. In the evolutionary process of architecture, past designs have usually been developed, and, innovations have been added to meet the requirements of the time; the Safavid era was no exception. Iran's roads were linked with worldwide commercial cultural traditions at this time, and the construction of the bridge as a constituent of the road was considered seriously in facing natural obstacles, especially rivers. During the reign of the Safavid dynasty, most of the bridges in Iran were built to create, maintain, and expand communication routes. New bridges were built with the transfer of the capital to Isfahan and Zayandeh Rood stationing in the middle of the city. Allahverdi Khan and Khaju Bridge, built on two floors, were among the most prominent architectural achievements of this era. The construction of the two-floor building of the bridge not only made it similar to its general appearance and differentiated it from other bridges, but also provided conditions for watching inside and around them, which has since attracted the attention of its audience. The proof of this claim is the texts of many travel logos that describe and praise the two bridges.

It seems that in the design of the Khaju Bridge, there are considered characteristics that diversity has deeply affected its physical features. Accordingly, there are many questions about this building, including how image documents along with descriptive documents can be used to identify the Khaju Bridge and the surrounding environment. This paper attempts to answer the following question:

What changes have occurred over time in the Khaju Bridge and the surrounding environment? Answering this question, due to the capital of Isfahan during the Safavid period, requires scrutinizing historical books and visual documents. Therefore, tables have been prepared to provide images of the bridge in different eras. Finally, the original form of the bridge has also been restored.

Research Methodology

This research is applied fundamentally in terms of approach, and also in terms of the method it is comparative studies. Information gathering has been done through library resources and visual documentation and based on the comparison of the forms, the visual model will reveal the shape of the Khaju Bridge at different times.

Background Research

• Khaju Bridge Naming

The reason for naming this bridge Khaju is that it is located near Chaharbagh Khajoo and some other sources have been called the Khaju Bridge by reason of the fact that the bridge was near the Khaju Bridge (Moradi et al., 2012; Luschey, 2017). For this bridge, various names such as Shahi Bridge, Baba Rokneddin, Shiraz Bridge, Hassan Abad Bridge, Teymouri Bridge, Hassan Beig Bridge, and Gabran are mentioned in the sources. One of the names of the Hassan Abad Bridge was chosen due to a name of the proximity of a neighborhood with the same name (Isfahani, 1989; Moradi et al., 2012; Jaberi Ansari, 1974; Afzal al-Molk, 2001; Luschey, 2017; Coste, 1867). Since the destruction of this neighborhood during the Afghan invasion, this name has not been used for the bridge anymore. The bridge has also been famous for Hassan Beig (Hassan Pasha) (Beheshtian, 1964; Coste, 1867; Hami, 1993). On the other hand, it is called the Shahi Bridge, because they built the bridge on the orders of Shah Abbas (Moravej Torbaty & Pour Naderi, 2014; Blake, 2009; Coste, 1867).

The name of the bridge was Baba Rokneddin because of the location of the bridge in the direction of the access to the Cemetery of the Takhte Foolad and the Tomb of Baba Rokneddin (Luschey, 2017; Loti, 1991; Pirnia, 2015; Tavernier, 1989; Coste, 1867). One of the reasons for naming this bridge, the Gabran Bridge was the placement of the Zoroastrian neighborhood next to the bridge (Moradi et al., 2012; Jaberi Ansari, 1974; Javari, 2005; Coste, 1867). The other name of this building was the Shiraz Bridge, which was due to its placement in the direction of Shiraz (Afzal al-Molk, 2001; Hami, 1993; Tahvildar, 1963; D'Allemagne, 1999). The reason for naming this building as Teymouri Bridge is due to the killing carried out on this bridge (Beheshtian, 1964). Also, in some other sources, the bridge was named Teymouri Bridge because this bridge was built on the older bridge of Teymouri dynasty (Luschey, 2017; Jaberi Ansari, 1974; Danesh Pajouh, 2006;

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Dieulafoy, 2006; Khayat Rostami et al., 2013; Rasouli, 2012).

Descriptive Document History

• History

The Khaju Bridge on the Zayanderod River connects the northern and southern parts of the river from the Safavid dynasty (Shafaghi, 1974; Rafiee Mehrabadi, 1973; Zander, 2018; Semsar et al., 2011). The Khaju Bridge was located just a short distance from the Palace of Ayeneh Khaneh (Moradi et al., 2012). The bridge that was built on the old path of Isfahan to Shiraz, is likely that its foundation was built in Hasan Bey Turkmen or Hassan Pasha era, a name from the Teymouri rulers. However, before the Safavid dynasty, in this place, there was a bridge connecting the city of Isfahan with the famous old cemetery and the famous Takht-e Foolad. During the reign of Shah Abbas, the simple bridge that was there was removed, and laid the foundation for Shahi Bridge which is today called the Khaju Bridge. It was constructed in 1060 Hijri and the 8th year of the monarchy of Shah Abbas II (Honarfar, 1997; Jaberi Ansari, 1974; Danesh Pajouh, 2006; Semsar et al., 2011; Chardin, 2000; Amir-Shah-Karami, 2006; Coste, 1867). It is also mentioned in other sources that Khaju Bridge was built about 1060 Hijri by Shah Abbas II, apparently on the foundation of the older bridge (Hami, 1993; Ataei, 2004). Mirza Taher Vahid, the chronologist and historian of Shah Abbas, said that there was a damaged bridge at the site of the bridge and maybe it was destroyed by the king's order (Jaberi Ansari, 1974; Hami, 1993). One of the reasons for constructing this bridge was Shah Abbas's fanatical views on the separation of other religions from Muslims. Shah Abbas seized the lands in the southwest of Isfahan from the Zoroastrians killed many of them and gave their lands to Armenians. Many of the remaining Zoroastrians left the city and went to another part of the southeastern lands of Isfahan. There, they built a neighborhood called Gebar Abad. Therefore, one of the reasons that Shah Abbas built the bridge was to prevent the passage of the Zoroastrians from the Si-o-se-pol which was especially for Muslims. Also, Marnan Bridge was built since the Armenians were not allowed to cross Si-o-se-pol (Amir-Shah-Karami, 2006). However, other resources mentioned that Shah Abbas II made this bridge to make it impossible for Zoroastrians to cross the Allahverdi Khan Bridge because this king did not have a good opinion of Zoroastrians. However, after the completion of the bridge, he moved Zoroastrians from there to another place, and he took the nearby areas from them and destroyed them, and in its place, the royal Sadat Abad palace was built (Moradi et al., 2012).

Unfortunately, there are no historical inscriptions relating to the construction of the bridge and its architect, and the only existing inscriptions provide some information on the repair of the bridge by "Nasrullah Khan" was named during the time of Naser al-Din Shah Qajar in 1920 Hijri (Farshad, 1997, 68). In the middle of the Safavid dynasty, the section Beylerbey was added to the bridge. Hossein Sadr Esfahani repaired the building of Beylerbey Palace on the Khaju bridge in the middle of Qajar (Loti, 1991). This part was destroyed during the Zell-e Soltan era (Flandin, 1977; Qazvini, 1942).

Surrounding Gardens

Also, Chahar Bagh Sa'adat Abad was built after the construction of the bridge. This royal garden was located on the two sides of the river and was enclosed with high walls. The street coming from Isfahan to this bridge is longer and wider than the Chahar Bagh street (Kiani, 1996). On the two sides, the sycamore tree is planted, but in the middle, there is no creek (Amir-Shah-Karami, 2006). On the streets of the bridge, the Gabran have built two buildings for the king, which sometimes comes and promenade; one of the two houses, which is located on the left side of the river is near the city and Shah Abbas gave it to the priests of the Kaposan dy nasty (ibid.).

The city of Isfahan has six large neighborhoods before the Safavid dynasty, so as:

1. Lonban
2. Karan Garden (Khaju of Isfahan neighborhood)
3. Karan
4. Jouybareh
5. Dordasht
6. Chanblan

Shah Abbas II Safavid (1052-1077 AH) constructed a street called Chahar Bagh Amin Abad on the south side of Khaju Bridge, parallel to the Chahar Bagh, and built gardens around it,

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among which Anarestan Garden and Kaj Garden (Mahmud Garden) were built in the east and Mostofi Garden and Negarestan Garden in the west that these Chahar Bargh called Gobrabad (Loti, 1991). Abdullah Khan Amin al-Dawla (dated 1263 AH) repaired there and since then it has been known as Chahar Bagh-e Amin Abad (ibid.). This street starts from the Khaju Bridge and ends on the first Takht-e Foolad and now is known as Feyz Street.

In some sources, Chahar Bagh Amin Abad is known as Chahar Bagh Malekshahi. Also, this street is named Chahar Bagh Sadri, Chahar Bagh Fath Abad, or Chahar Bagh-e- no in sources (ibid.).

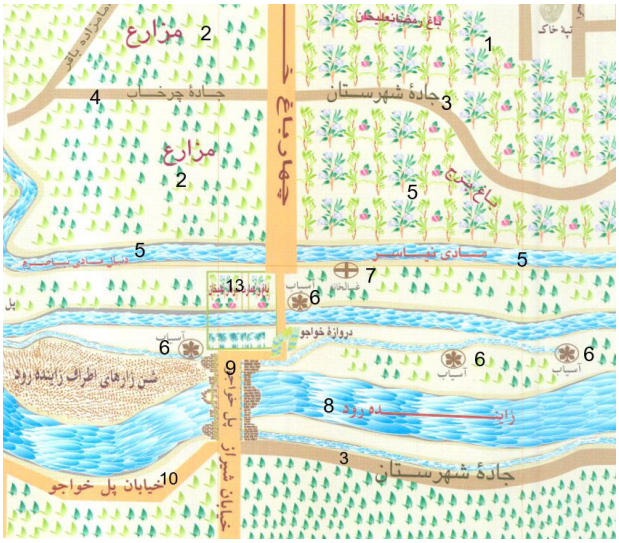
Physical Features

The length of the Khaju bridge is less than si-o-se-pol. The length of the bridge is about 131.[57] meters and the average height of the bridge is 11.[65] meters. The bridge has 21 canals and numerous arcades and pavilions (Danesh Pajouh, 2006; Mokhlessi, 1999).

The bridge had a special place which used by the King of Safavid and his family in the ceremonies and celebrations (Tahvildar, 1963; Coste, 1867). The foundations of the bridge are located on a platform or solid foundation. The platform, which serves as a dam, elevates the river's water level, and stores some water for dehydrated seasons, is made of turning rock fragments (Moradi et al., 2012; Jaberi Ansari, 1974; Mokhlessi, 1999; Mazaheri, 2000). This platform, in the direction of the water flow, is built in stairway mode and the steps have a low height, in the direction of the water openings are cutaways or canals in the middle of the grooves, which by putting some boards in it, the water openings were blocked and the river level got high about 2 meters and reached the main surface of the openings. In times of intense flood, water could flow through all the openings (Tavernier, 1989). Between its long axis, it raised the stone bases of the bridge and constructed brick vaults on them (Moradi et al., 2012; Jaberi Ansari, 1974; Beheshtian, 1964).

The passage is flat on the bridge and has a wide range of passageways for pedestrians and river viewers (Farshad, 1997, 67). Beiglarbeigy building was designed for the residence of the king and his family. The building had rooms with painting, calligraphy and tile work (Luschey, 2017; Jaberi Ansari, 1974; Manavi, 1990). Also, on both sides of the two ends of the bridge, smaller buildings were built that seemed to be used by the relatives of the king (Danesh Pajouh, 2006; Mokhlessi, 1999; Mohammadi & Molazade, 2000; Wills, 1989).

One side of this bridge was Sa'adat Abad Garden. Also, Sadr Isfahani connected his



1	Ramazan Ali Garden	2	Farms	3	Shahreštan Road	4	Charkhab Road	5	Niasarm Canal
6	Water Mill	7	Mortuary	8	River Zayanderod	9	Khaju Bridge	10	Khaju Street

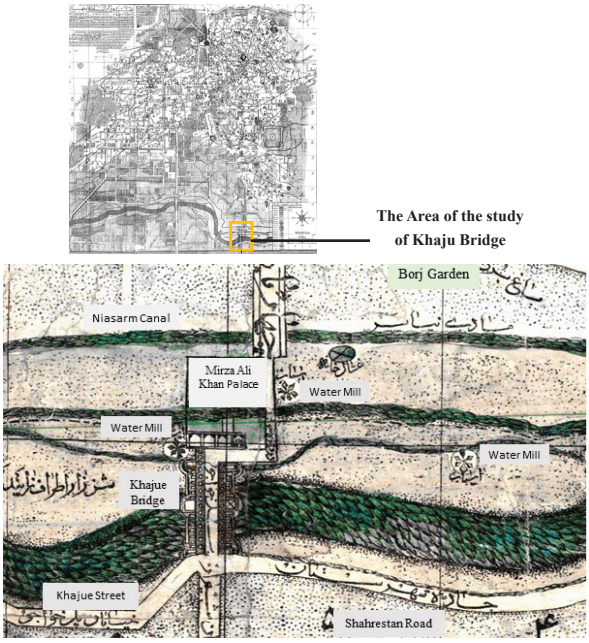


Fig. 1. Seyed Reza Khan's plan. Source: Cultural Heritage Documentation Center of Isfahan Province.

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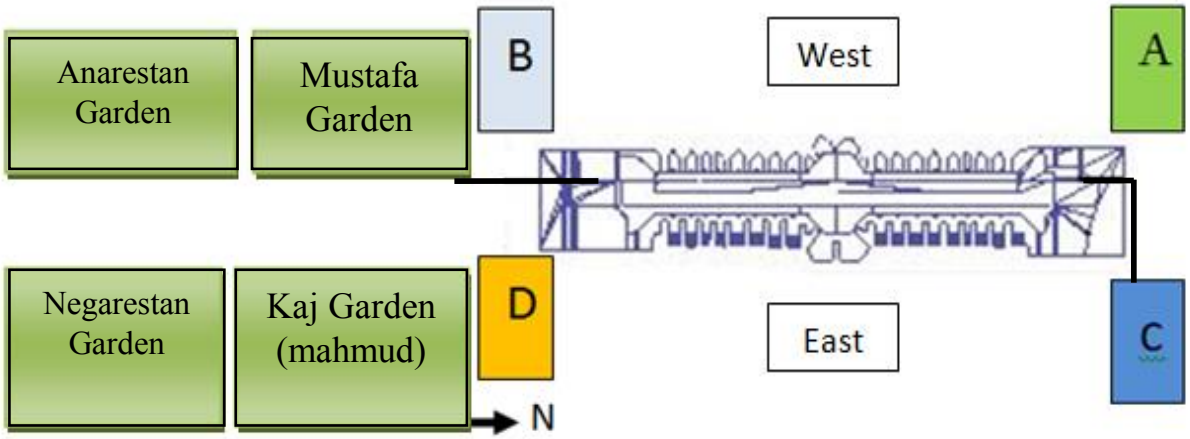

Fig. 2. Geographic directions and gardens around the Khajou Bridge. Source: Authors.

Northern Chahar Bagh, known as Fath Abad, to this bridge (Isfahani, 1989, 109).

The great Khaju which led to the desert, was Tofangdarbashi Palace, Mostofi Bazar, Mostofi House, and the Sheykh Baha House, and before they were numerous the watermill, and finally, the morgue was in the end. The Sheikh Baha'i house (953-1030 HA) is the latest building outside the city in this neighborhood; from there to the village of the Shahrestan, there were pleasant farms, and on the other side, Mohammad Ali Beig grove (Manavi, 1990, 36; Mahdavi, 1966) (Table 3).

Changes in the Khaju Bridge and the Related Surrounding Environment Over Time

Based on the existing surveys, available images of the Khaju Bridge show that during the different periods of the Khaju Bridge and the surrounding areas, there have been significant changes. Therefore, for an accurate examination of the Khaju Bridge, its different directions were examined separately. Thus, to check the bridge and its surrounding area more accurate maps (Fig. 1) and its surrounding framework were investigated (Fig. 2).

• Southeastern part of Khaju Bridge

In different periods, major changes can be seen in the southeastern part (Fig. 2, Section D). At first, the Kaj Bagh (known as Mahmud) was located there (Fig. 2). In the corner of the western side of Kaj Bagh, there was a tower (Table 1, Sections 1 & 2).

The tower, on the northwest corner of the Kaj Bagh (Mahmud), had framed simple walls with regular arcades (Table 1, Section 1), then the walls of the garden were destroyed (Table 1 - Section 2), and later, the simple walls surrounded the Mustafa garden and Kaj Bagh (Table 1, Section 2). At this time, the walls of the garden were made with a simpler wall in the form of a vault (Table 1 - Section 2). Also, the length of the eastern walls of the Kaj Bagh is clear (Table 1, Section 2 & 3).

In later periods and after the destruction of the tower (Table 1 - Section 3), a watermill was also built here (Table 1, Section 4). Then, the watermill was also destroyed in such a way that in the remaining images of the midst of the Pahlavi I era, the watermill no longer exists (Table 1 - Section 5)

After that, the walls of the garden are destroyed and a stone ramp is replaced. There are several buildings in this section that one is made of a gable roof on the wooden column. The southeast part of the bridge is the route to the Shahrestan road (Table 1, Section 1).

• Southwest of Khaju Bridge

The study on the southwest of the bridge (Fig. 2, Section B) indicates that, due to the presence of gardens and the king's palace in this part (the palace of Haft Dast/ Ayneh Khaneh/ Namakdan palace), people's access to this part was not possible. Those who came from the north to the south through the bridge could only continue the direct route (Table 2, Section 1), or choose their route to the eastern side (Fig. 2, Section D). In this part, the walls of Sa'adat Abad garden were grandstanded. This wall has been connected to the southern part of the bridge. In the next period, especially

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Table 1. Image documentation of the South East Bridge. Source: Authors.

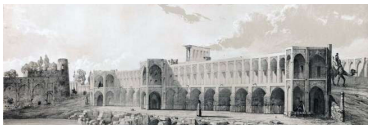
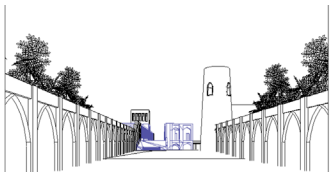
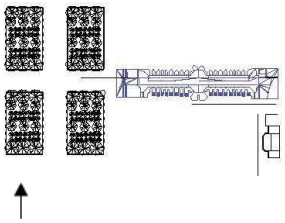
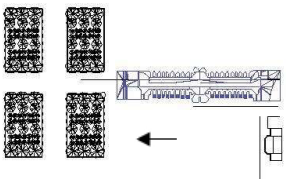
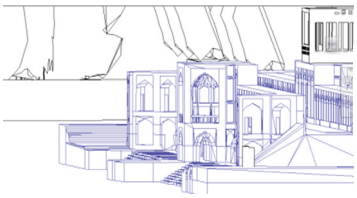
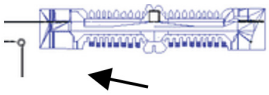
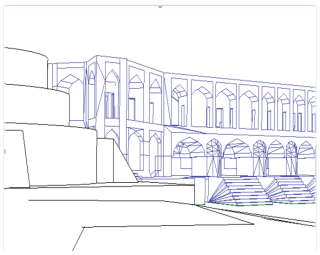
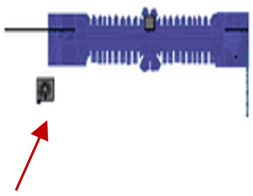
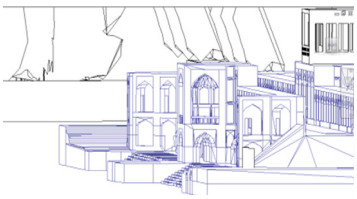
Section & Era	Figs.	Perspective	Plan
1- Safavid	 Source: Flandin. Source: Pascal Coste.		
2- Qajar	Source: Flandin.		
3- Qajar	Source: Flandin.		
4-Late Qajar	Source: Flandin.		
5- Pahlavi	Source: Flandin.		

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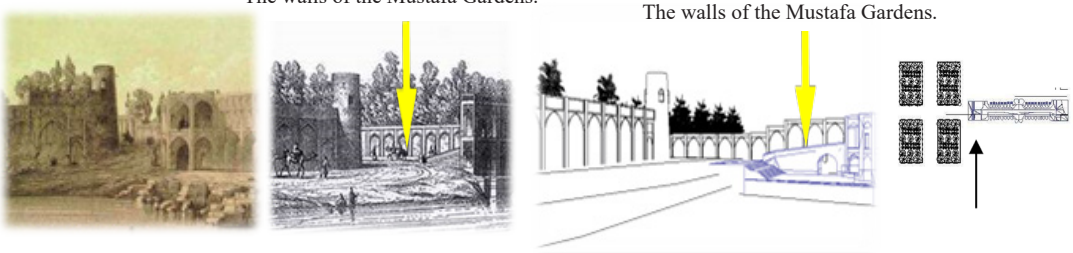
Table 2. Southwest of Khaju Bridge. Source: Authors.

Section & Era	Figs., perspective & plan
1- Safavid	The walls of the Mustafa Gardens.  The walls of the Mustafa Gardens.
2- Qajar	

during the late Safavid dynasty in the time of Afghan invasion, and later in the Qajar era, destruction occurred in this part, so that after the abandonment of the king's palaces and gardens, easy access to this part was provided. At this time, the route from the south side of the bridge to the west side was provided (Table 2, Section 2).

Two continuous images taken in less than a few minutes express a new pathway that has emerged after the destruction of the wall. In this image, there is a jockey with his horse who is dressed in garments of the Qajar era (Table 2, Section 2). In one of the visual documents, the length of the walls of the Mustafa Gardens is clear (Table 2, Section 1).

• Northeast of Khaju Bridge

According to surveys, the northeastern side of Khaju Bridge (Fig. 2, Section A) has seen plenty of structural changes. In this part of the garden, a tower was located (Fig. 1). Next to the Khaju Bridge in the north, the small Khaju neighborhood and the Hassan Abad gate have been located (Naseri, 2009; Honarfar, 1978; Beheshtian, 1964). Also, in the northeastern parts of this bridge, a caravanserai, a mosque, a bathroom, and the Kaj Bagh were located (Loti, 1991; Manavi, 1990) (Fig. 1). The most ancient image documents of this part indicate that in the vicinity of the bridge in the northeastern part, there was a building that had a facade like a caravansary (Blake, 2009) (Table 3, Section 2). In some documents, mistakenly, this kiosk is considered to be on the Northeast part of si-o-se-pol, which is not, since the study of the old images indicates that the form of the north-eastern part of the Khaju Bridge appears in the photographs (Table 3, Section 2). In addition, the trees next to the Khaju Bridge and on the opposite kiosk show this entirely (Table 3, Section 2). This building was destroyed in the late Qajar, and

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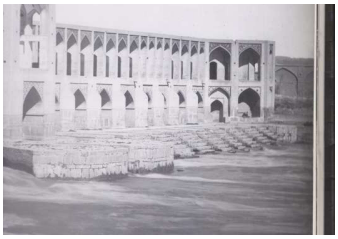
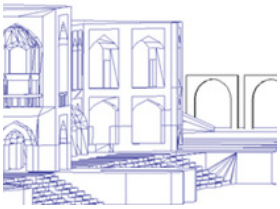
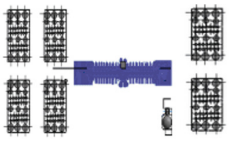
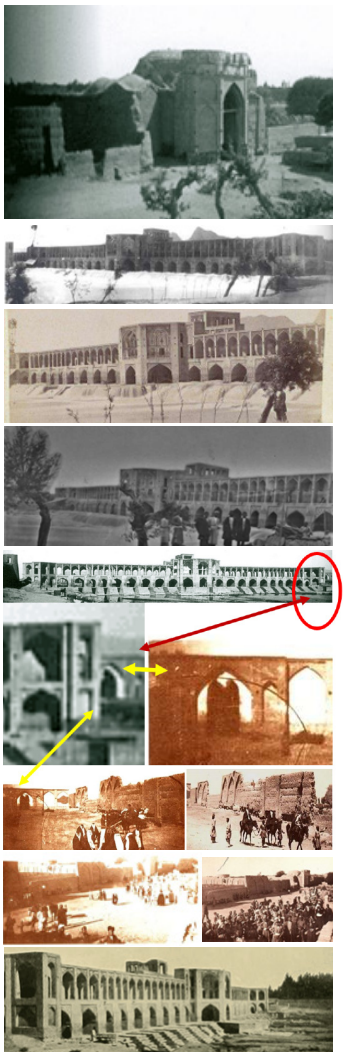
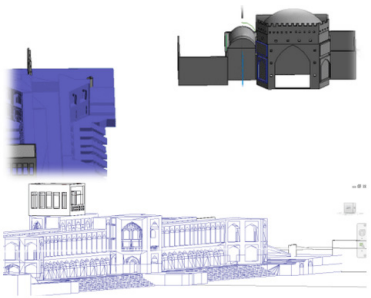
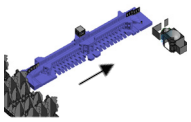
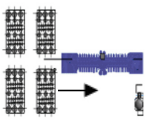
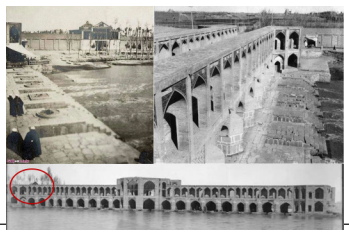
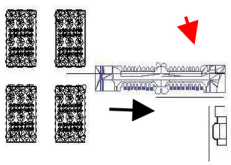
Table 3. Northeast Khaju Bridge. Source: Authors.

Section & Era	Figs., perspective & plan
1- The wall is in the form of an arc	  
2- First Pahlavi The crescent with a head in front sat in the form of a half-eight	   
3- Late Pahlavi and early second Pahlavi	 
4. Pahlavi	

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instead, a kiosk was built up in the middle of the building with a pediment covering and has led to a hypostyle part (Satavand) in the proscenium (Table 3, Section 4-A). The walls of this building created the north-east coast of the bridge through the regular framing of the wall (Table 3, Section 4-B).

This building was also destroyed in the early era of Reza Shah. The connected wall to the bridge had a curved form (Table 3, Section 5). The continuation of Canal Niasarm passed from in front of the garden. There were two watermills in this part (Fig. 1). Historical text and pictures left indicate that access to Khaju street from this part (North side of the bridge) was not directly possible (because of the king's gardens) and when someone moved from the south to the north, must first go east and then enter the Khaju District (Kiani, 1996) (Table 3, Section 2).

• Eastern facade

The eastern facade of the bridge (Fig. 2, section E), has not undergone many changes. Apart from this fact that in the king's palace, some decorations were added in the Qajar era, next to the northern side of this part, there was a wall in the form of a bridge facade, which led to a tower (Fig. 1). On the south side of the bridge, there is the distance between the tower and the Kaj Bagh and the facade of the bridge (Table 4, Section 3).

In this part, like the western part, there were

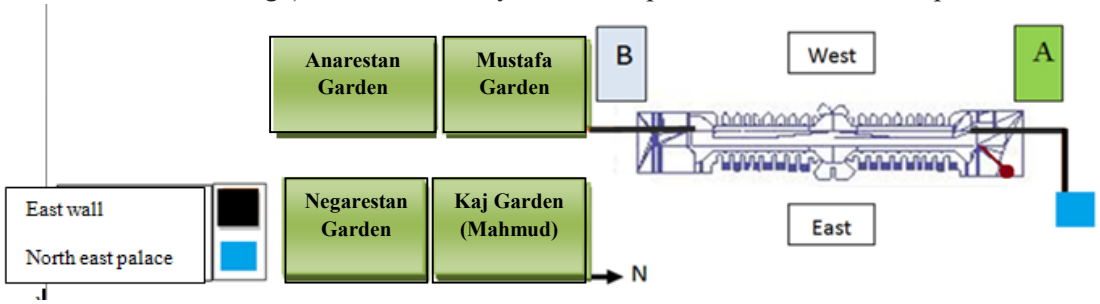
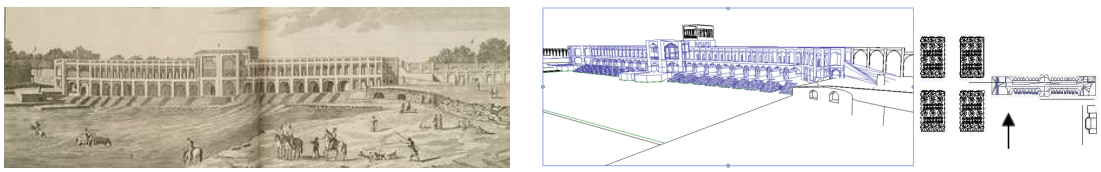
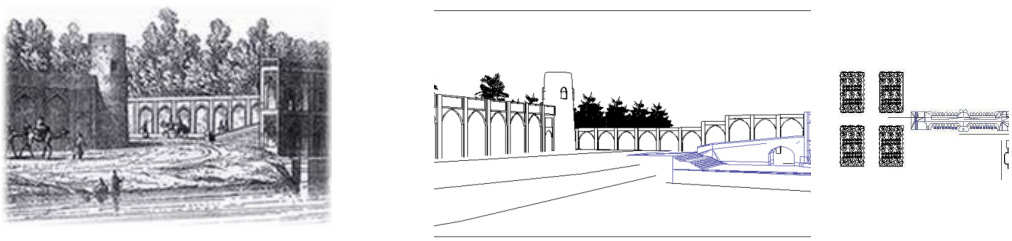


Fig. 2. Geographic directions and gardens around the Khajou Bridge. Source: Authors.

Table 4. The eastern structure of the bridge. Source: Authors.

Section	Figs., perspective & plan
1	
2	
3	
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walls to redefine the north-south path of the bridge, which later these walls were destructed from the bridge (Table 4-Section 4).

• Western facade

In the old photographs of the Khaju Bridge and descriptive documents, it can be seen that there was a building on the western side of this bridge (Fig. 2, East Section). In the descriptive documents, it is referred to as Beiglarbeigy (Table 5, Section 1). This building was built in the early Qajar era and the late Qajar era, it was destroyed partly, and then during Reza Shah's era, it was completely destroyed. Next, to the north of the bridge, there are walls with regular frames on both sides of the bridge. Next to the south of the bridge. There was also a wall (previously discussed) blocking access to the gardens in Sa'adat Abad's palace.

• North west

On the northwest side of the bridge, there were continuation gardens of the Khaju neighborhood. In the historical maps, the name of the Charkhab farms is clear in this part. Also, in this part, besides the river, there were three other canals. The first canal passed from the bottom of the opening of the bridge which is found in new explorations (Table 6). The second canal also passed through the garden and the Sardar Ali Khan palace and the third canal passed slightly below the Chaghbargah Khaju, which is the Canal Niasarm. The first and second canals were separated directly from the river from the northern side of the bridge (Fig. 1). Canal Niasarm is parallel to the river path and is a short distance from the bridge also In this part and at a distance about 10 m from the bridge there

Table 5. Western Structure. Source: Authors.

Section	Figs. & plan
1	
2	

Table 6. Northwest of Khaju Bridge. Source: Authors.

Section	Figs., perspective & plan
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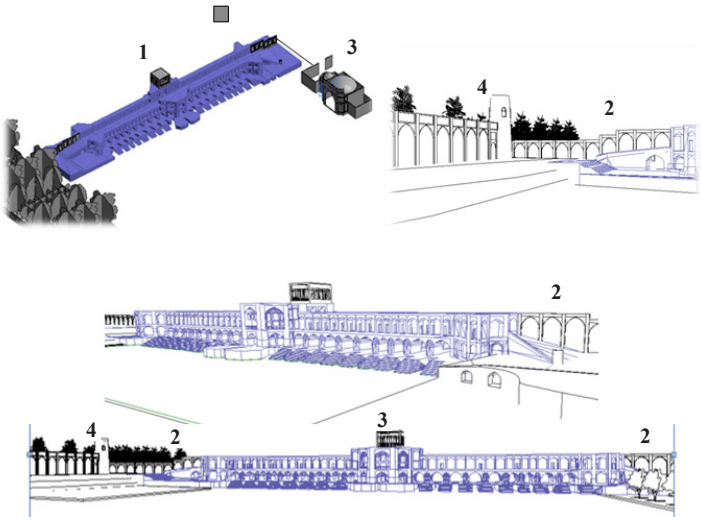
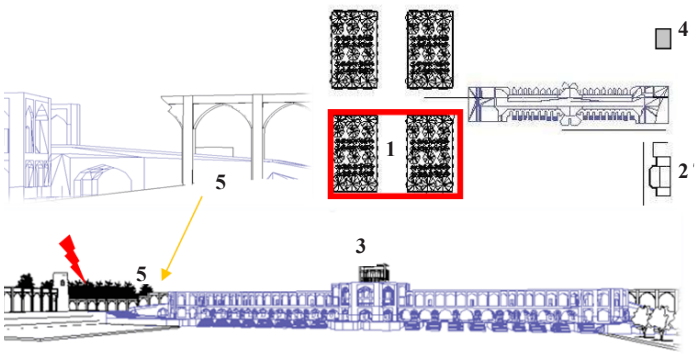
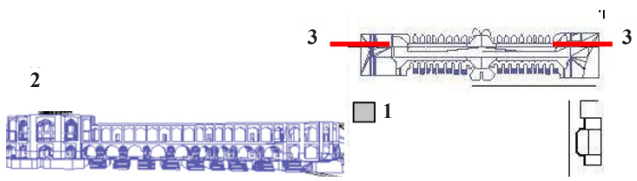
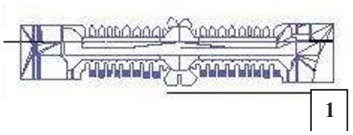
Table 7. Changes in Plan and Facade Bridge Khaju over time. Source: Authors.

Era/Description	Figs., perspective & plan
The Qajar era 1- Building of the Beiglarbeigy (on the west side of the bridge) 2. Walls on the western side of the bridge along the north-south axis of the bridge 3-building with a coffee house until late 1309 (northeast bridge) 4. Kaj tower (Mahmud) (south-east bridge)	
Late Qajar era 1- Destruction of Kaj tower and garden, Garden of Negarestan (south-east bridge) 2- Destruction of Northeastern Building and Building Mirza Palace (You East Bridge) 3. Demolition of the Ceiling Beiglarbeigy 4. Construction of the Watermill (Northwest Bridge) 5. Open access to West West (Southwest)	
Late Pahlavi and early second Pahlavi 1. Making the volume instead of the Kaj tower (southeast) 2-total destruction of the building Beiglarbeigy 3. Complete destruction of the walls of the western side in the north and south 4. Construction of walls for Charkhab farms (northwest bridge)	
Late second Pahlavi 1. The demolition of Mirza Palace (northeast bridge)	

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is a watermill (Fig 1. Seyed Reza Khan map) (Table 6- Section 2).
The northwest facade of the bridge in this part to the north has been decorated with framed walls (arcade facade) on two floors (Table 6- Section 1). In subsequent periods, as is shown in the north-eastern images of the bridge, they have opened the openings which are led to the northwest (Fig 2- Northwest map). Also in the Pahlavi, I era, modern construction with simple rectangular frames is located on this side (Table 3). At this time the watermill was completely damaged (Fig. 3 & Table 7).

Conclusion

Reviewing the visual documentation and the descriptive documents of the physical changes of the Khaju Bridge and its surrounding buildings identify several major changes. Descriptive documents, for instance, reveal the northwestern and southwestern side uses which shed light on the later change in access to the western side. Also, descriptive documents indicate the names of the buildings and places that were built next to the bridge and identify the surrounding elements of the bridge.
On the southeastern side, during the construction of the building, there was the Bagh Kaj (Fig. 2). There was a tower in the corner of this garden which is visible in the figures (Table 1, Section 1, 2 & 3). In the middle of the Qajar era, the garden was destroyed and replaced by another garden (Table 1, Section 2 & 3). During the Pahlavi era with the construction of a street in this section, an inclined plane is created for convenient access to the street (Table 1, Section 3). Until the middle of the Qajar era, there was a watermill on this side (Table 1, Section 4). which was destroyed in late Qajar images (Table 1, Section 5).
During the Safavid dynasty, the southwest side was not accessible and there was a wall next to the bridge (Table 2, Section 1; Fig. 3). The descriptive documents indicate that due to the location of the royal garden of Sa'dabad, the palace of Ayeneh Khaneh, and the palace of Haft Dast, the access of ordinary people to it was restricted. However, in the middle of the Qajar era, the arcades were destroyed or palaces were destroyed which allowed access to this area(Table 2, Section 2). In the next era, it was completely destroyed (Fig. 4).
On the Northeast, according to image documents, there was no direct path from the bridge to the northeast, and the direct path was blocked (Table 3, Section 1). All passengers had to move northwest to reach the Khajou gate, which was the entrance of Chaharbagh Khajou (Table 6, Section 2). In this section, there was a consecutive wall perpendicular to the bridge which was in front of the bridge building and Sardar Ai Khan garden (Fig. 3). In the next era, instead of a consecutive wall, a palace building according to European architecture style with an inclined plane is placed (Table 3, Section 4; Fig. 3). This building was destroyed in the next era and simply framed walls have remained which was destroyed in the next era (Table 3, Section 4).
In the northwest side which was not accessible through the bridge during the Safavid dynasty (Table 4, Section 1), with the destruction of the wall perpendicular to the bridge in the next era,

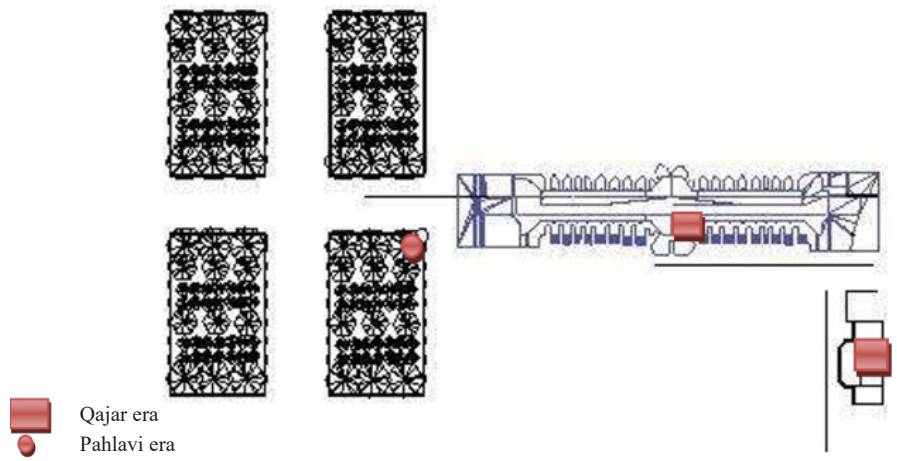

Fig. 4. Qajar era at a glance Source: Authors.

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a watermill is being made (Table 4, Section 3). After the destruction of the watermill, a modern building was constructed in the back of this watermill at Pahlavi I dynasty which later was transferred to the Blood Transfusion Department (Table 4, Section 2 & 3).

On the western side of the bridge, the stretch over the northern and southern walls blocked the access to the west of the bridge (Table 6, Section 3). Also, a building was constructed in the middle of the western side in mid-Qajar on the alcove mansion, which was destroyed in the Pahlavi I era (Table 6, Section 3). In the late Qajar, the western side was opened in the south and north. On the eastern side, there is no special change over time (Table 6, Section 3).

Conflict of Interest

The authors declare that there was no conflict for them in conducting this research.

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