

The impact of ancient history, conflict and globalization on bridge aesthetics in Iran

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ABSTRACT: The development of civil society in Iran and the surrounding region contributed to the creation of the first bridge structures. The first bridges built in this region, around three to four millennia ago, were strongly influenced by the Mesopotamian, and later Persian culture. With the shifting political climate in Iran, the forms and construction techniques used for bridge structures have developed, shifting the focus from Persian architecture and technology before the 20th century to Western architecture and technology in the 21st century. However, after the 1979 Islamic revolution in Iran, there has been a resurgence of Persian style forms and architecture in bridge structures. This paper looks at how politics, conflict and globalization has influenced the aesthetical forms of bridges built in Iran throughout its history and to the present day.

1 INTRODUCTION

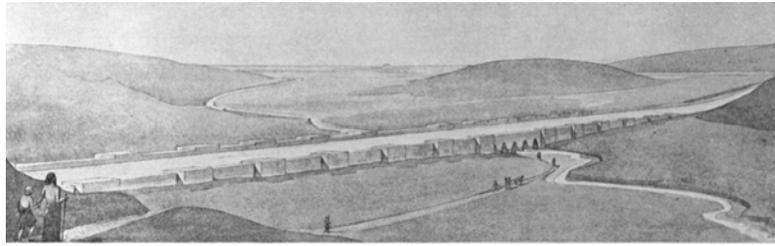
1.1 *Background*

After the creation of civilized societies in the middle east, humans began to develop tools and techniques to improve their daily lives. One of the greatest challenges for these early societies was creating a safe and efficient transportation system between their farm lands and their homes. The need to safely cross a river led to the development of the first man-made bridges, which relied on the use of arches. The first arch structure was constructed around 2000 BC in Ancient Mesopotamia, located in present day Iraq, Iran, Syria and Turkey (Brown 2005). Following this, the arch was adapted for use over rivers throughout the region, providing a safe passage over water.

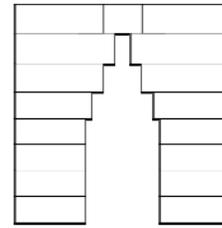
One of the earliest records of a bridge was that of a crossing built over the Euphrates in Babylon in the 7-6th century BC (Brown 2005). Around the same period, the corbelled stone aqueduct at Jerwan was constructed (Jacobsen 1935). The use of the corbelled arch, pictured in Figure 1, was a significant advancement in bridge technology and architecture. The use of the arch in bridge construction was adopted by numerous societies in the region, and was a critical part of bridge structures for thousands of years.

The history of bridge engineering and architecture is intertwined with the political and social evolution of society (Brown 2005). As the development of bridge technologies and construction techniques spread throughout the world, each society altered the materials and aesthetics to suit their regions. Understanding the history of these structures, and of the regions where they were built, can therefore provide an insight into the key role that these bridges provide in their historical and geographical context.

This paper looks to examine the influence that cultural and political changes can have on bridge construction and architecture throughout Ancient Persia and present day Iran. As part of this exploration, the influence of Persian culture and societal norms are discussed, providing insight into how they led to the development of new bridge construction technologies and aesthetics.



i) Sketch of the Jerwan Aqueduct in Ancient Mesopotamia.



ii) Corbel arch form.

Figure 1. Jerwan Aqueduct from Figure 6 of Jacobson (1935), and corbel arch (from Rcirraider, Wikimedia, 2012).

2 THE HISTORY OF ANCIENT PERSIA AND MODERN IRAN

The history of present day Iran can be traced back to the ancient Mesopotamian and Persian empires. One of the world's oldest settlements, dating back to 7000 BC, is believed to have been located in present day Iran (Dodd 2007). In the fifth century BC, the Persian empire dramatically grew in size, ruling over 44% of the world's population (Guinness 2017). After the fall of the Persian empire to Muslim civilizations around the eight to tenth century AD, the country was converted to Islam (Zarrinkub 2007). In 1501, the Safavid dynasty unified Iran into an independent state, and converted the population to Shia Islam (Bearman et al. 2005).

In 1906, Iran formed its first national parliament and created its first constitution. This change in governance provided some political stability in Iran, and helped to bring the country into the modern era (Iran Chamber Society 2017). The new constitution created new opportunities throughout the country, sparking the development of new bridge construction technologies and techniques. However, the advent of stability was paired with an increased influence from European countries. As a result, many of the bridges built in the region during this time were either constructed by European engineers, or heavily influenced by the advanced technologies developed in Europe.

After the 1953 coup d'état by the US and UK, Iran became even closer with the western world, gaining increased access to western engineering technologies (Kizner 2003). During this period, many American engineering companies began building new bridge structures in the region. These new structures did not use the traditional architectural styling developed in the region, and were instead based on the aesthetic norms developed in Europe and North America.

In 1979, Iran went through a political revolution which resulted in the creation of an Islamic Republic. One of the main impacts of the revolution was the emergence of Iranian nationalism, and the rejection of western influence throughout the country. This had a profound impact on the science and engineering community in Iran (Dehbashi et al. 2004). In the early 1990s, Iran experienced a brain drain of approximately 15% of highly educated individuals (Carrington et al. 1999), which impacted the quality and stylings of bridge construction in the region. This exodus of Iranian engineers and architects, caused by the Iran-Iraq and the brain drain, further reduced the influence of Persian architecture on bridge structures (Farahani 2012). However, in the past few decades, the political situation in Iran has stabilized, resulting in the resurgence of some Persian architectural forms and ideals in new bridge structures.

3 HISTORICAL TIMELINE OF BRIDGE CONSTRUCTION

The influence of Persian and Iranian culture and politics on the aesthetics of bridges constructed in the region can be studied by considering the signature bridges built in the region over the past few millennia. A timeline of these signature bridges, selected based on their popularity in the region, are presented in Figures 2 and 3. The classification of the bridges built in Iran can be broadly separated into three eras, with each era being defined based on the political and social climate in the region.

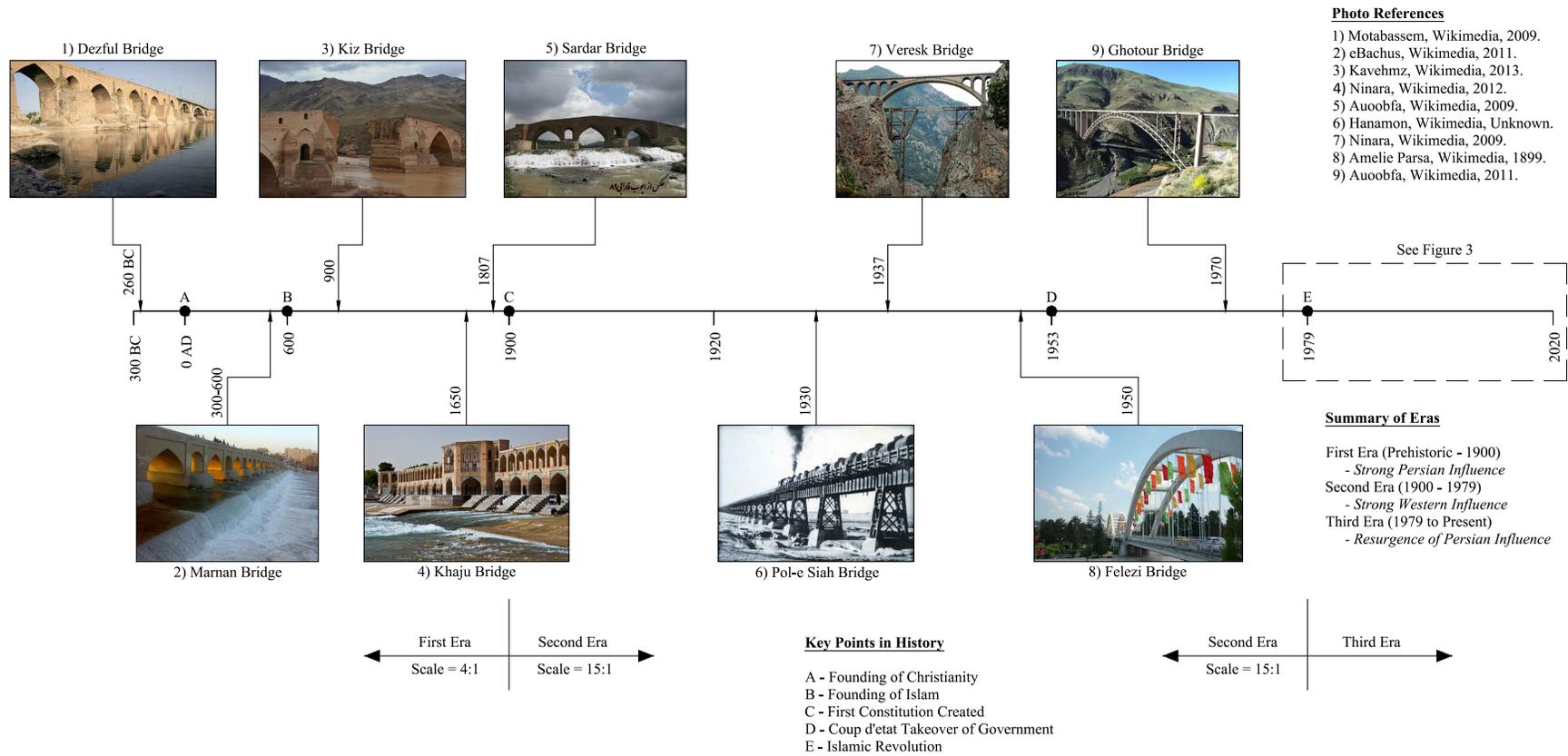


Figure 2. Timeline of bridge construction in Iran from 300 BC to 1979.

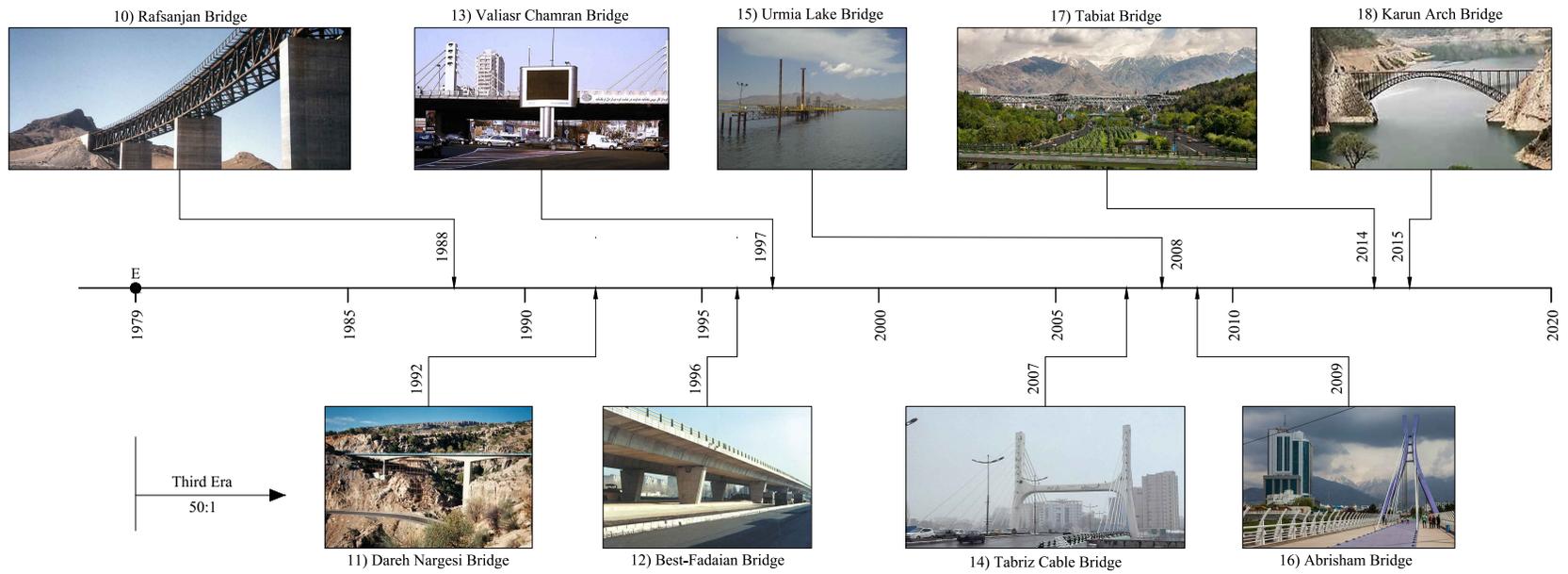


Photo References

- 10) Waagner-Brio, 2006.
- 11) Hexa, 2015.
- 12) Hexa, 2015.
- 13) Zereshk, Wikimedia, 2007.
- 14) AmirAK, Wikimedia, 2015.
- 15) Karzarj, Wikimedia, 2007.
- 16) Ninara, Wikimedia, 2012.
- 17) Diba, Wikimedia, 2015.
- 18) Mohseni, Wikimedia, 2015.

Figure 3. Timeline of bridge construction in Iran 1979 to the present.

3.1 First Era of Bridge Construction (Prehistoric – 1900)

The first era, which ranged from prehistoric times up to approximately the year 1900, was dominated by the development and use of stone and brick arch bridges. This period can be considered as the golden age of bridge construction in the region. The bridges built during this time were strongly influenced by the cultural stylings of the Persian society, and built by talented Persian bridge engineers and architects. Some of the most famous examples of stone and brick arch bridges built during this period include the Kiz Bridge, Khaju bridge and Shahrestan bridge, all of which are linked together in their choice of structural form and construction techniques, despite being built almost 10 centuries apart. During the first half of this era, many of the advancements in bridge technology occurred in Iran and the surrounding region. This period coincides with the golden age of Islam, which occurred from the 8th to 13th century AD (Saliba 1994). During this time, the Islamic world was governed based on science and economic development, allowing these cultures to flourish.

3.2 Second Era of Bridge Construction (1900 - 1979)

The second era, ranging from the year 1900 to the Islamic Revolution in 1979, was sparked by the development of the constitutional monarchy in Iran. The increased political stability during this period is reflected in the increased western influence throughout the country. This western influence had a significant impact on the structural forms and construction techniques used throughout the region.

In the first half of the second era, from approximately 1900 to 1953, European engineers had a major influence on the construction of new bridges in the region, often designing and building bridges with minimal input from their Iranian counterparts. An example of this is the masonry arch Veresk Bridge, which was designed by the Danish Engineering firm Kampsax (Iran Front Page 2016). The Veresk Bridge was designed to replicate the bridges being built throughout Europe at the time, such as the reinforced concrete Salginatobel bridge designed and built by the Swiss engineer Robert Maillart. These two bridges, shown in Figure 4, are both representative of European bridge construction and architecture.



i) Veresk bridge, located in Iran.



ii) Salginatobel bridge, located in Switzerland.

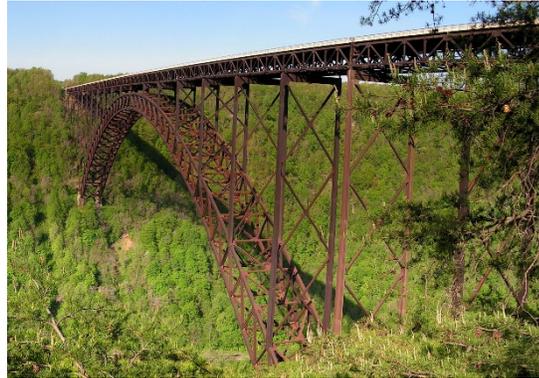
Figure 4. Veresk Bridge (from Ninara, Wikimedia, 2009) and Salginatobel Bridge (from Rama, Wikimedia, 2008).

The second half of this era was sparked by the coup-d'état, which overthrew the democratically elected Prime Minister and strengthened the power of the Monarchy. This coup-d'état was orchestrated by the US and the UK to reaffirm their influence in the region (Merica et al. 2013). During this period, there was a significant increase in the number of American companies that were building bridges throughout Iran. Like their European counterparts, these engineers constructed bridges to match the ones built in the United States. An example of the increased American involvement is with the Ghotour bridge, which was designed by the American design firm Sverdrup & Parcel, and built by the American Bridge Company in 1970 (MacCartney 1973). The Ghotour bridge is very similar in style to the New River Gorge Bridge, which was built in

1977 in West Virginia, United States. The similarities between these two bridges is shown in Figure 5.



i) Ghotour bridge, located in Iran.



ii) New River Gorge bridge, located in Virginia.

Figure 5. Ghotour Bridge (from Auoobfa, Wikimedia, 2011) and the New River Gorge Bridge (from Gabor Eszes, Wikimedia, 2006).

The second era is marked by strong US and European influence on the bridge structures built in Iran. This mirrors the political climate, with the US and European countries playing a key role in the political and economic situation in Iran. However, the deviation from traditional Iranian architecture and culture helped to spark a resurgence of Iranian nationalism, which led to the Iranian revolution.

3.3 *Third Era of Bridge Construction (1979 - Present)*

The third era, ranging from 1979 to the present day, was sparked by the Islamic revolution. The revolution acted as a catalyst for the re-emergence of the traditional Persian style of architecture, particularly in bridges being built in the region. After the revolution occurred, the influence of western styles of architecture were denounced, and Iranian engineers and architects began to take back the bridge construction industry. Although the bridges being built during this time still have a strong western influence, many of the traditional forms and stylings from the region were reincorporated into these bridges. The two main examples of this are the re-emergence of the pointed arch, and the creation of new bridges that not only serve to provide a crossing, but to act as a meeting space for the Iranian society. More recently, the Iranian Science and Engineering community has been reporting some of the fastest scientific progress in the world (Coghlan 2011), allowing the younger generation of Iranian engineers and architects to develop new and unique styles that accentuate both the history and the current culture in Iran.

4 CASE STUDIES

The influence of Persian culture and architecture on bridge construction has been developed over millennia, in parallel with the political and economic situation in the region. These influences are highlighted through the study of some of the most famous bridges built in Iran. By comparing the features of bridges built in ancient times, during the height of the Persian empire, to bridges being built in present day Iran, the lasting influence of the Persian culture on bridge construction and technologies is explored.

4.1 *Khaju Bridge (1650)*

The Khaju bridge, located in the province of Isfahan, was erected around the year 1650 by the Persian King Shah Abbas II (Brown 2005). The Khaju bridge, shown in Figure 6, is 133 m long and spans the Zayandeh River with 23 stone arches.



Figure 6. Khaju bridge, located in Isfahan, Iran (from Ninara, Wikimedia, 2012).

The bridge serves as a dam which uses arch brick sluices to control the flow of water in the river (Brown 2005). In addition, the two-storied bridge provides walkways and meeting areas beneath an arcade of pointed arches. The bridge widens at each abutment and at the center of the river to provide a larger gathering place, which was initially used as both a teahouse and a viewing outpost for the King (Cakmak 2016).

The Khaju bridge serves as a prime example of the Persian style of bridge construction. First, the bridge is not seen purely as a means to cross the river. Instead, the architects and engineers envisioned that the bridge would create a new public space where people could gather as a community. The idea that public structures should provide more to users than the bare function of a bridge stems from the architectural ideals developed throughout the history of the Persian empire. This is evident in other bridges built in the region such as the Allahverdi Khan Bridge and the Shahrestan Bridge, shown in Figure 7.



i) Allahverdi Khan bridge, located in Iran.



ii) Shahrestan bridge, located in Iran.

Figure 7. Allahverdi Khan bridge (from Ninara, Wikimedia, 2012) and the Shahrestan bridge (from Offlineinternet, Wikimedia, 2008).

The similarities between the Khaju Bridge and the Allahverdi Khan and Shahrestan bridge extend beyond the use of the bridge structure to create new public space. All three bridges make use of the pointed arch. This form of arch was first used by the Persians in the 7th to 10th century BC as part of the Khorasani style of architecture, and has since been a key aspect in most signature structures in Iran (Pope 1971). This includes the pointed arches used in the famous Azadi

tower, located in Tehran. The Azadi tower, shown in Figure 8, is a center piece in the Iranian capital city that represents the finest in Persian architectural forms.



Figure 8. Azadi tower in Tehran (from Bayat.amir, Wikimedia, 2014).

4.2 *Tabiat Bridge (2014)*

The Tabiat Bridge, which translates as the “Nature” bridge, is a pedestrian bridge located in Tehran that spans over the Modarres Highway. The 270 m long steel tubular truss bridge was designed by the Iranian architect Leila Araghian, after she won a national design competition designed to create Iran’s next signature bridge. The fact that a woman architect was chosen highlights the prominent role that woman play in the development of engineering and architecture in Iran, where more than half of science and engineering students are women (Masood 2006).

Completed in 2014, the multi-storey bridge, shown in Figure 9, provides curved pathways that are intertwined, preventing people from using the bridge as a throughway (Archdaily 2014). The winding nature of the bridge, mixed with the various lookouts and meeting points, maintains the traditional architectural stylings seen in older Iranian bridges. The young architect used the bridge to provide “a place for people to stay and ponder, not simply pass” (Regencia 2015). This theme is consistent with traditional bridge structures in Iran such as the Khaju Bridge.



Figure 9. Tabiat bridge, located in Tehran (from Diba Tensile Architecture, Wikimedia, 2015).

The structural form and materials of the bridge are influenced by the technologies developed in western countries. These technologies, such as the use of steel tube trusses, has been adapted

to Persian architectural styles by maintaining the ideal that the infrastructure should be part of the surrounding environment and community. For the Tabiat bridge, this is taken in a literal sense by forming the piers as roots and branches that support the main truss span. However, the need to create large meeting spaces has resulted in a structure that is much larger and bulkier than would normally be required for a pedestrian bridge at this location. The total cost of the bridge, which was approximately \$18.2 million USD, was driven by the desire to create a large public space (Radoine 2016). Due to economic sanctions placed in Iran during this time, the sourcing and transportation of materials was difficult and resulted in numerous delays (Regencia 2015).

4.3 *Abrisham Bridge (2009)*

The Abrisham Bridge located in Northern Tehran is a cable stay pedestrian bridge with an inclined tower. Completed in 2009, the 133 m long bridge, shown in Figure 10, has a main span of 67 m, and approach spans of 43 m and 24 m.



Figure 10. Abrisham bridge, located Northern Tehran, Iran (from Ninara, Wikimedia, 2012).

The bridge was designed by the Iranian engineering firm Hexa Consulting Engineers, and built by local contractors (Hexa Consulting Engineers 2017). Whereas other middle eastern countries rely heavily on the use of western engineering firms, the use of Iranian engineers and builders pays homage to the strength of the engineering community in Iran. This also allows for the bridges in Iran to implement regional architectural forms, providing unique insight into the cultural setting and history of the region.

Unlike traditional pedestrian crossings in the region, the bridge does not provide winding paths and pavilions for public space. However, the 10.5 m wide multi-use bridge deck allows users to leisurely cross the bridge and stop to enjoy the views. The bridge type and materials are heavily influenced by western technologies and architecture. The inclined tower, for example, is derived from other inclined cable stay bridges in the western world such as Santiago Calatrava's El Alamillo Bridge in Spain, shown in Figure 11.



Figure 11. El Alamillo Bridge, located in Spain (from Hermann Luyken, Wikimedia, 2007).

Despite this, the Abrisham bridge incorporates some traditional aspects of Persian architecture. For example, the designer chose to have the two main pylons curve inwards above the roadway. The curve of the A-Frame tower seems to be of similar shape to a pointed arch. This pays homage to the pointed arches used in the majority of the bridges built before the 20th century in Iran.

5 CONCLUSION

The construction of the first arch structures in Ancient Mesopotamia sparked a technological revolution that helped create the first modern bridge structures over 2000 years ago. These bridges relied heavily on the use of rock and stone to form arcades over rivers and small valleys. With the military and cultural success of the Persian empire, the region began developing a unique architectural styling. In the 7th to 10th century, the Khorasani style of architecture was created, leading to the development of the pointed arch, which was adopted as one of the main aspects of Persian architecture for the next thousand years.

There are two main aspects of bridge structures, developed during the peak of the Persian Empire, that define the Persian style of architecture. The first aspect is the use of the pointed arch form in bridges, buildings and cultural monuments. This feature is prominent in most bridges built in Iran before the 20th century, including the Allahverdi Khan bridge. The second aspect is the use of bridges as public space, and not just as a means to cross a river. This feature is part of many of the ancient bridges developed during the Persian Empire such as the Khaju bridge, and a few that have recently been built in Iran such as the Tabiat bridge.

The development of a constitutional monarchy in Iran resulted in an increased influence of the western world on the political and economic situation in Iran. This also resulted in an increased influence on the bridge structures built throughout the region. Many European and American engineering firms came to Iran to construct new bridges, using architectural forms developed in the western world, and for the most part, paying little homage to the architectural stylings developed in the region. This fact is evident when comparing the bridges built in Iran by European companies, such as the Veresk bridge, to the bridges built in Europe, such as the Salginatobel bridge.

As a rejection of the strong western influence in Iran, the revolution in 1979 reduced the amount of western influence in the region. This has, in part, led to a revival of the architectural forms that were developed during the peak of the Persian Empire, such as the pointed arch and the use of bridge structures as public spaces. This is due to the fact that more Iranian engineers and architects, who have studied in Iran or abroad, are working on the major infrastructure projects in Iran. This revival has resulted in the construction of new bridges that use traditional Iranian culture and aesthetics in the development of their structural form. With the current stability in the region, and the increasing number of Iranian nationals gaining higher education around the world, the contributions of Iranians to the bridge engineering community will likely continue to increase, reflecting the rich history of technological innovation coming from the region.

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