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The Formation and Evolution of Spiral Staircases in Pre-Islamic Iranian Architecture

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Abstract

Iranian architecture has been a pioneer and innovator in the structural, technical, and artistic fields worldwide, producing valuable masterpieces throughout historical times. Despite this, there are many unknowns and ambiguities regarding its various aspects, including issues related to design, execution, techniques, and architectural elements. In this regard, although Iran is recognized as one of the pioneers in the design and construction of the first spiral staircases, as well as in demonstrating the important role of this element in the architecture of various historical periods, no comprehensive scientific study has yet been conducted, and therefore its origin, formation process, and evolution remain unclear. Focusing on these ambiguities, and relying on archaeological sources and data, the present study adopts a descriptive-analytical approach to determine Iran's role and position in the construction of spiral staircases. Based on the research conducted and considering references in Latin sources to the earliest identified example of a spiral staircase in Italy dating back to 480 BC, the first identified example in Iran is much older and dates back to the late second millennium BC, although similar examples had previously been identified in the regions of Syria and Mesopotamia. The process of their formation and expansion in the architecture of the first millennium BC in northwestern Iran (Hasanlū V and IV) and western Iran (Bābā Jān III and the main Median settlement at the Nush-i Jan site), and their continuation during the Achaemenid (Susa), Parthian, and Sasanian periods (Qal'a-ye Dukhtar and the palace of Artaxerxes I in Firuzabad), can therefore be traced and studied. This architectural element has subsequently secured a permanent place in the Islamic period.

Keywords: Spiral Staircase, Architecture of the Iron Age, Median Architecture, Susa, Hasanlū.

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Introduction

With a history of about ten thousand years, Iranian architecture has pioneered and innovated in various structural, technical, and artistic fields and has presented valuable masterpieces to the world across different historical and Islamic periods. Despite nearly a century of research on various aspects of traditional Iranian architecture, many untold stories and details unfortunately remain unstudied and unclear due to the lack of historical documents and the limited survival of architectural remains. These include issues related to design, execution, techniques, and architectural elements. Meanwhile, despite the fact that Iran is one of the pioneers in the design and implementation of the first spiral staircases, and despite the important role of this architectural element in various historical periods, no scientific research has yet been conducted on this subject, and its origin, formation process, and evolution remain unclear. The origin of this architectural element, its formation process, and evolution have been explained in different ways across other cultural contexts.

Flat-beamed roofs are common in the architecture of various regions of Iran, especially in the Zagros region. Access to the roof (and later to the upper floors of the building) was a necessity due to the preservation and maintenance of thatched roofs and their various functional uses. For this reason, solutions have been developed from the prehistoric period to the present to provide easy and quick access to the roof or upper floor. Typically, portable wooden ladders were the simplest solution in the early period and were often used along the outer wall of buildings. However, gradually, to enable quicker and safer access in buildings with important functions, and in response to climatic conditions -especially during the cold seasons in the Zagros region- as well as the high density of certain settlements, staircases were relocated inside buildings and constructed using more durable materials; nevertheless, the earlier method has continued in simpler buildings in the architecture of the region to this day. Considering the importance of architectural space, architects preferred to implement the staircase in the most efficient manner while occupying the least possible space. The spiral staircase thus emerged as the most effective solution in such a way that, thousands of years after its formation, it has been used in approximately the same way in various governmental, religious, tomb, memorial, and other types of buildings by different ethnic groups.

Problem Statement

As mentioned in the introduction, the spiral staircase is an important

architectural element with a long history in Iranian and world architecture. However, to date, no comprehensive scientific research has addressed its origin, formation processes, underlying reasons, evolutionary development, or architectural characteristics in the prehistoric and historical periods of Iran, leaving fundamental questions unresolved, which the present study seeks to address through archaeological evidence from various prehistoric and historical contexts. Recognizing and systematically examining the formation and evolution of this architectural element can clarify the pioneering contribution of Iranian architecture in introducing innovative concepts to world architecture and contribute to revising existing theories concerning the history and development of spiral staircase construction.

Research Methods

In this research, data collection was carried out through both field investigations and library-based research, and data processing was conducted using a descriptive–analytical approach. The time frame of the research extends from the emergence of the spiral staircase in the second half of the second millennium BC to the end of the Sassanid period, and the geographical framework of the research primarily encompasses the Iranian Plateau. However, in order to examine the stages of formation and to provide a more comprehensive analysis of this architectural element, examples beyond the aforementioned geographical framework have also been considered.

Spiral Staircases and Factors Behind Their Adoption A "spiral staircase" consists of a series of steps constructed using different materials and techniques, organized around a central column or pillar and enclosed by a surrounding wall, which was initially quadrilateral in form and later developed into a circular layout; in most cases, the staircase revolves clockwise around the central pillar (and counterclockwise in examples such as Bābā Jān and Hasanlū), providing access to roofs or upper floors. Based on this definition, a spiral staircase can be distinguished from later stair types that lack a central pillar, commonly referred to as helical staircases.

A spiral staircase requires more complex planning and construction than conventional staircases and, consequently, its development must have been motivated by specific functional and architectural considerations. It appears that the principal reason for adopting this design, which remains valid today, is the limited space required for constructing this type of staircase compared with conventional alternatives. Optimal use

of architectural space has long been, and continues to be, a fundamental principle for designers, architects, and building users.

Another reason for adopting this design was to restrict and control access to upper floor(s), a consideration closely linked to issues of security and movement control in historical contexts. This function is particularly evident in the staircases of castles and important governmental buildings. Many spiral staircases in medieval European castles and in buildings of the historical and Islamic periods of Iran were constructed with narrow passages and dimly lit interiors, and their rotation commonly followed the direction of clock hands. The constructional characteristics of these staircases hindered attackers, who typically wielded swords in their right hands, by restricting both movement and visibility, while defenders positioned on the upper steps could strike more effectively toward those below. In other words, the central column or pillar functioned as a defensive shield for the defender.

A third reason, more characteristic of later periods, concerns the aesthetic appeal and visual attractiveness of spiral staircases compared with more conventional stair types.

These functional, structural, and aesthetic considerations collectively explain why, following its development, this type of staircase came to be widely used across diverse geographical regions, civilizations, and cultural contexts, appearing in both religious and secular architecture -including castles, churches, mosques, and funerary monuments- and being constructed using a variety of materials and building techniques.

Literature Review

The data and information available have primarily been published through excavation reports and descriptive accounts of the architectural remains recovered from these sites. The results of Dyson's excavations at Hasanlū have provided key evidence for some of the earliest spiral staircases associated with the Iranian Iron Age in northwestern Iran (Dyson, 1977; 1989 a, b). Goff's excavations at Bābā jān demonstrate the continued construction and use of such staircases in western Iran (Goff, 1968; 1970; 1977). The results of the excavations carried out by the Stronach Archaeological Team at Nush-i Jan have revealed more developed and architecturally refined examples of these staircases during the Median period (Stronach & Roaf, 2007). The construction of spiral staircases appears to have continued, though on a more limited scale, during the Achaemenid period (Ladiray, 2013; Perrot, 2013; Hesse, 2013). Variants

of these staircases in later forms have been reported from the Qūmis site dating to the Parthian period (Hansman, 1968; Hansman et al., 1970; Hansman & Stronach, 1974). Such staircases are also preserved at Qal'a-ye Dukhtar of Firuzabad (Huff, 1976; 1978 a, b; 2005) and at the Firuzabad Palace (Michell & Eaton, 1992).

A Historical Analysis of the Construction and Use of Spiral Staircases
Although the use of stairs and staircases in conventional forms is nearly as old as architecture itself, the spiral staircase, with its more complex and evolutionary design, emerged comparatively later. The remains of the staircase foundation of Temple A at Selinunte in Sicily, Italy, date to around 480 BC and are presented in most sources as the earliest surviving example of a spiral staircase (Miles, 1998: 2, Fig. 1). In the same body of literature, the internal staircase of Trajan's Column in Rome is also described as one of the earliest surviving spiral staircases in the world (Lancaster, 1999: 425, Fig. 4), constructed and completed in 113 AD (Ibid: 419). According to written sources, the history of such staircases extends back even further. In the Old Testament, reference is made to the building constructed by Solomon in the fourth year of his reign (about 966 BC): "… and they went up with winding stairs into the middle chamber, and out of the middle into the third" (Old Testament, Kings I, 6, 8). However, architectural history sources generally fail to acknowledge earlier examples preserved in Iran that more clearly demonstrate the formation and evolutionary development of this architectural element.

New archaeological data offer a clearer picture of the development of this architectural form. The limited survival of prehistoric architectural remains makes it difficult to study all construction details, particularly systems of access between spaces. However, based on archaeological excavations in Syria and Mesopotamia, it appears that the earliest stages in the formation of this type of staircase belong to this region and date to around the third millennium BC. At the site of Eshnunna, a ruler's palace from the late third millennium BC has been excavated, where a spiral staircase was discovered adjacent to the reception hall and its entrance space (Stronach & Roaf, 2007: 187). This type of staircase was later repeated in similar architectural contexts within Assyrian palaces, eventually becoming a standard feature, although variations in construction details are observable (Ibid).

By the middle of the second millennium BC, in northwestern Iran at the ancient site of Hasanlū (Dyson, 1989 a, b), a distinctive architectural tradition emerged, the central feature of which was the columned hall. Gradually, during the late second and early first millennium BC, spiral

staircases, and later columned porticoes, were incorporated into this architectural scheme, eventually becoming a fixed component of this type of plan and spreading across different regions (Stronach & Roaf, 2007; Goff, 1968; 1970; 1977). This architectural element continued to occupy an important position in Iranian architecture during subsequent periods as well. It is therefore essential to examine the processes of formation, development, and continuity of this feature during the Iron Age, as well as in the Median, Achaemenid, Parthian, and Sasanian periods, all of which have thus far received insufficient scholarly attention.

The Formation Process of Spiral Staircases in Iran

The first identified examples of spiral staircases on the Iranian plateau date to the Iron Age I period (1450–1200 BC). The Iron Age in Iran and surrounding regions was characterized by significant developments in technology, economy, culture, and communication, including the growth and advancement of architecture and its structural components, among them the spiral staircase, which forms the focus of the present study (Mollazadeh, 2014: 211–212). The successive stages in the formation and development of architecture during this period, which later provided the foundations for Median and Achaemenid architectural traditions, and in particular the emergence and development of spiral staircases, can best be examined through evidence from the site of Hasanlū. This site functioned as the center of a wealthy local polity with extensive commercial, political, and cultural connections during Iron Age I, remaining active until approximately 800 BC (Dyson, 1977; 1989).

Iron Age I and II: Hasanlū

Hasanlū is located in West Azerbaijan Province, on the Solduz Plain at the southwestern edge of Lake Urmia, and represents a settlement sequence extending from the sixth millennium BC to the Ilkhanid period (Dyson, 1989a: 6). According to Dyson's chronology, Level V of the site corresponds to an Iron Age I settlement (1450–1250 BC), while Level IV is attributed to Iron Age II (1250–800 BC) (Roaf, 2012: 2). This chronological framework has recently been revised by Michael Danti (Danti, 2013: 53–142); however, these revisions do not affect the present discussion.

In Level V, a new architectural pattern appears in comparison with earlier phases, characterized by a plan centered on a columned hall accompanied by a counter, a spiral staircase, and surrounding rectangular rooms (Fig. 1). In Level IV, this architectural scheme was further expanded and refined

in terms of scale, design, and structural details, subsequently serving as a model for Median and Achaemenid architecture and continuing, with modifications, into later periods within the architectural traditions of the Zagros region.

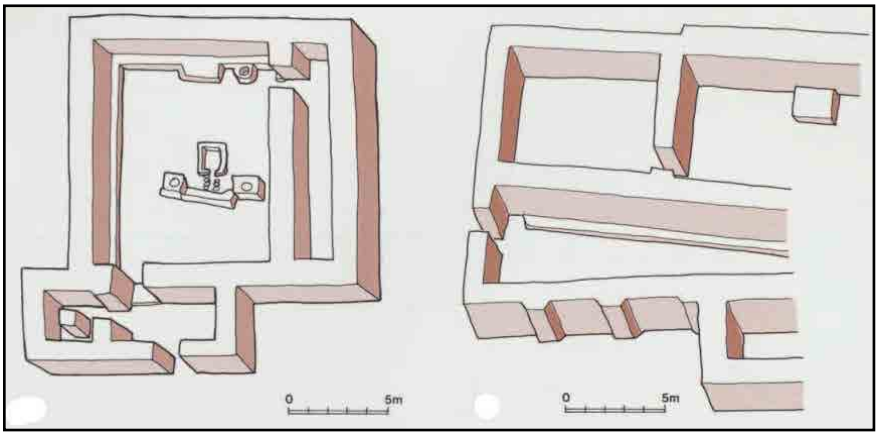
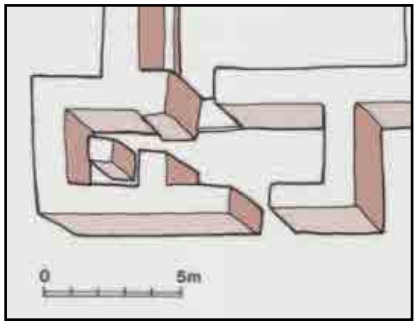


Fig. 1: Isometric drawing of architectural remains discovered in the Level V of the Hasanlū site (Dyson, 1989 b, 108, Fig. 2a, b). ▶



▲ Fig. 2: Isometric drawing of the architectural remains of the counter and the spiral staircase discovered in the Level V of Hasanlū (Dyson, 1989 b, 108, Fig. 2a).

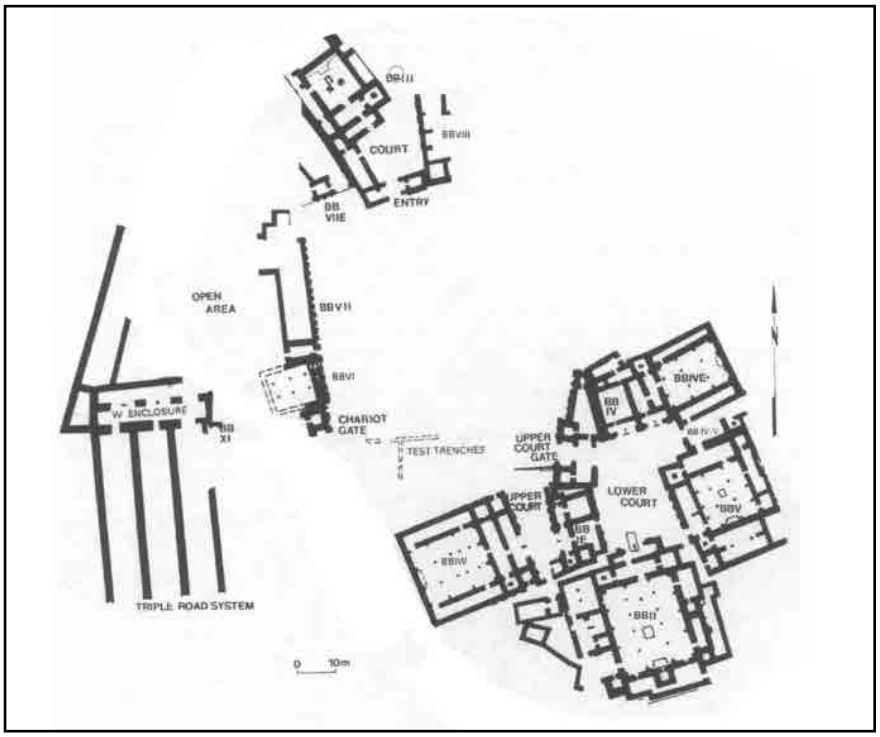
To date, the earliest identified spiral staircases in Iran have been discovered in Level V at Hasanlū, dating to approximately 1450–1250 BC (Fig. 2). In this level, two residential units have been uncovered, each comprising a counter, staircase, columned hall, surrounding rectangular rooms, and mud-brick benches. Due to the limited extent of the excavations, however, it has not been possible to reconstruct the complete layout or all architectural components of the complex, and it remains possible that additional staircases existed within this level. As noted, each residential unit accessible from the counter appears to have contained a spiral staircase. Each staircase occupies a square space entered from the counter and includes a central mud-brick pillar. The building foundations were constructed of rubble stone, while the upper sections were built of mud-brick. No additional architectural elements of the staircases have survived to clarify the precise construction technique of the steps. However, based on the remains of the staircase from Building BB IV in Level IV of the site, it appears that the lower portions of the steps were constructed of mud-brick, while the upper sections were likely made of wood, possibly accompanied by a mud-brick arch surrounding the central pillar.

A relatively complete building from Level V was excavated at the northern end of BB VII in Trench RS22-23, and based on radiocarbon analysis, it has been dated to 1360–1290 BC (Dyson, 2012: 34). Reconstructions based on Level IV buildings indicate that the structure featured a hall measuring 2.6×8.85 m, with a staircase at its southern end measuring 2.6×2.6 m, centered on a mud-brick pillar of 60×80 cm. The

steps, apparently constructed from raw mud-brick, spiraled around the central pillar from the room floor, providing access to the second floor and the roof of the passage (Ibid).

With the gradual expansion and evolution of architectural designs in Level IV (1250–800 BC), seven spiral staircases have been identified in religious, governmental, and residential buildings of Level IVB (Fig. 3). Four staircases are located to the right of the entrance, and three to the left, reflecting a proportional relationship to the overall building plan (Fig. 4). The dimensions of the central pillar and the surrounding four walls vary according to the overall proportions of each building. Some are square-rectangular in shape (BB II), others exhibit a more irregular plan (BB V), while the staircase in BB IW, the most recently constructed building on this level, presents the most regular, near-square plan among these examples.

The dimensions of staircase rooms and their central mud-brick pillars in Level IV buildings range from 4×5 m (BB III) to 2.7×2.9 m (BB IE), with central pillars varying from 1.3×1.2 m (BB III) to 0.7×0.7 m (BB IE) (Dyson, 2012: 34–35). The steps ascended in a counterclockwise direction. While the columned halls were single-story, the side rooms were two-story, and access to the flat roof was a functional necessity in regional architecture from prehistoric times onward, serving tasks such as annual maintenance of thatched roofs and providing usable seating or activity areas during the warmer months.



◄ **Fig. 3: Map of architectural remains discovered in Level IVB of Hasanlū (Dyson, 1989 b, 112, Fig. 6b).**

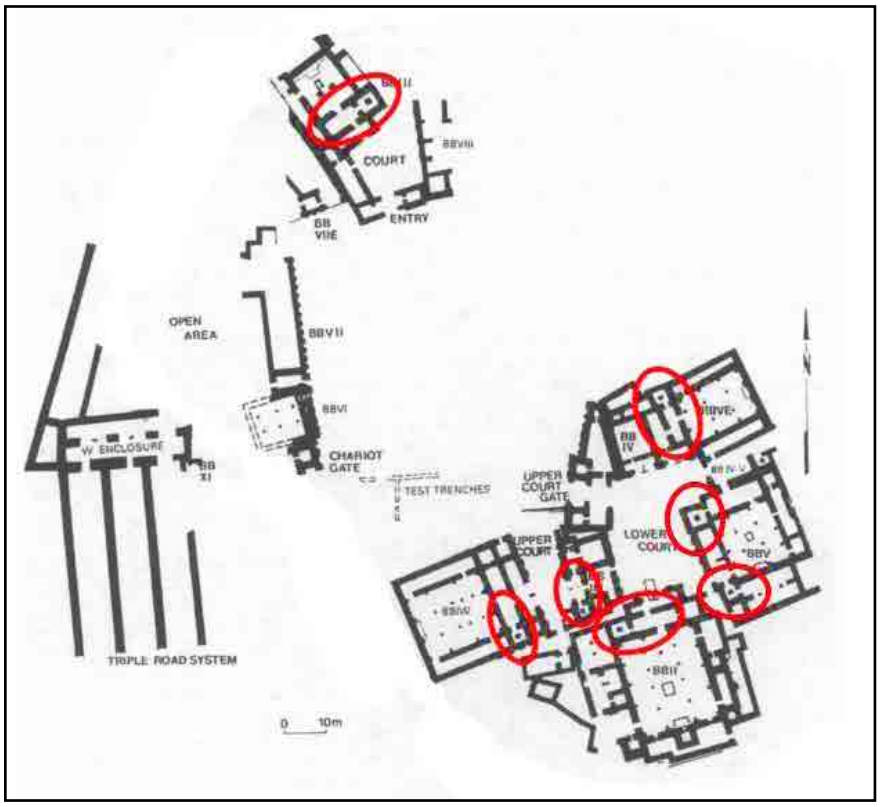


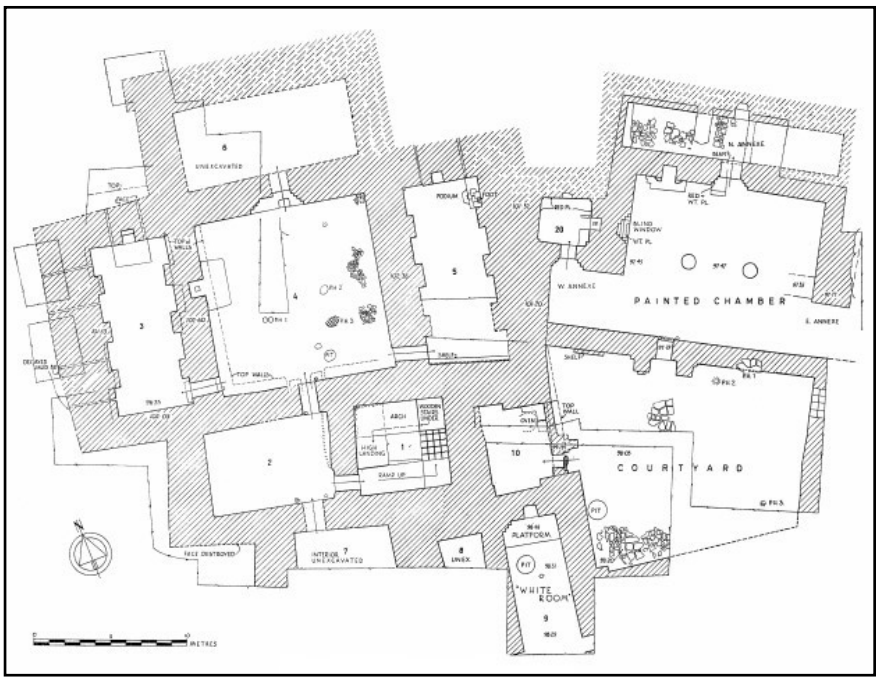
Fig. 4: Map of the architectural remains of the counter and the spiral staircase discovered in the level IVB of Hasanlū (red parts) (Dyson, 1989 b, 112, Fig. 6b). ▶

] The steps in the lower section were constructed from mud-bricks directly on the ground. The remaining architectural evidence is insufficient to provide precise details regarding the construction of the upper steps or the exact distance between the central pillar and the surrounding four walls. It is possible that the upper steps were supported by wooden beams (Dyson, 1989 b: 119). Given the availability of advanced arching techniques during the Median period, arches were commonly incorporated into spiral staircases at the Nush-i Jan site (Stronach & Roaf, 2007: 187). However, no comparable evidence has yet been identified at Hasanlū.

Considering the data presented, it appears that the construction and use of spiral staircases on the Iranian Plateau during Iron Age I (1450–1250 BC) were established and expanded at Hasanlū. Factors such as the environmental conditions of the Zagros region, the emergence of a ruling class and associated elite architecture, and extensive cultural interactions with neighboring regions, particularly Mesopotamia and Syria (see: Young, 2012: 81–102), all contributed to this development. Consequently, the architectural forms and staircases implemented in northwestern Iran during the 9th and 8th centuries BC spread to western Iran, with their evolved examples observable in chronological sequence at the Bābā Jān and Nush-i Jan sites.

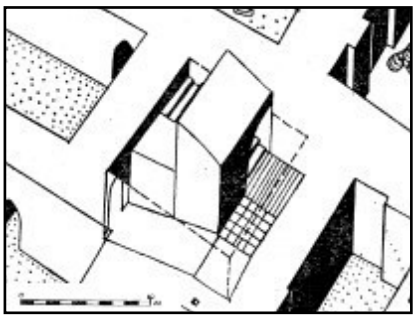
Iron Age II: Bābā Jān Archaeological Site

Bābā Jān is located on the Delfan Plain, near the city of Nurabad in Lurestan Province. The site was excavated by Goff between 1966 and 1969. An administrative complex dating to the 9th century BC was uncovered on the eastern mound, featuring a spiral staircase within its counter (Fig. 5–6) (Goff, 1970: 150–151). Like the examples from Hasanlū, this staircase comprises a four-walled enclosure with a central cubic pillar. After the entrance, a sloping mud-brick surface winds around the central pillar. Beyond the first landing, the ramp's height decreases, likely to accommodate the continuation of the steps and their connection to the next landing, which may have involved several steps or a wooden sloping surface; burnt wooden remains were found in this section.



◄ **Fig. 5: Map of the architectural remains discovered from the level III of the eastern mound of Bābā jān (Goff, 1977: 104, Fig. 1).**

The central pillar was constructed independently but was connected to the ramp at the top and to the west, serving as support for the remains of an arch on the second landing, which was probably linked to the northern wall of the staircase area. The arch did not survive the excavation, as it had collapsed before detailed documentation could be made (Ibid). Based on the evidence and reconstruction, the staircase provided access to the second-floor rooms and the roof of the building (Goff, 1977: 113). The spiral staircase at Bābā Jān ascended in a counterclockwise direction, similar to the examples from Hasanlū.



▲ **Fig. 6: Isometric reconstruction of the architecture of the spiral staircase discovered from Level III of the eastern mound of the Bābā jān site (Goff, 1977: 110, Fig. 6).**

Considering the similarities between various elements of the Bābā Jān complex, such as the columned hall, the counter, the spiral staircase, the

portals, and the stair-shaped niches, and the architectural plan of the Hasanlū complex, and taking into account the dating of the Hasanlū examples, it appears that the architectural developments originating in northwestern Iran during the 9th century BC were transmitted to western Iran through connections between local authorities and cultural networks. These design features subsequently became a standard tradition in the construction of governmental buildings and in the broader architectural practices of the Zagros region in later periods.

Median Period: Nush-i Jan

The Nush-i Jan site, located on the Malayer Plain in southern Hamedan Province, is one of the most significant sites of the Median period, notable for the durability of its architectural components and elements, and holds a special place in the history of Iranian architecture (Mollazadeh, 2014: 103–137). The site was excavated between 1967 and 1977 by an archaeological team led by Stronach (Stronach & Roaf, 2007). During these excavations, a religious complex dating to the Median period (circa 750–625 BC) was uncovered, and its occupants, upon leaving the site, had carefully filled the spaces and prepared the ground in a manner that contributed to the preservation of the structures. Of particular importance to the present study is the discovery of four spiral staircases, some of which are exceptionally well preserved (Fig. 7). These staircases are associated with the central temple, the old western building, the fort, and the northern area of the site.

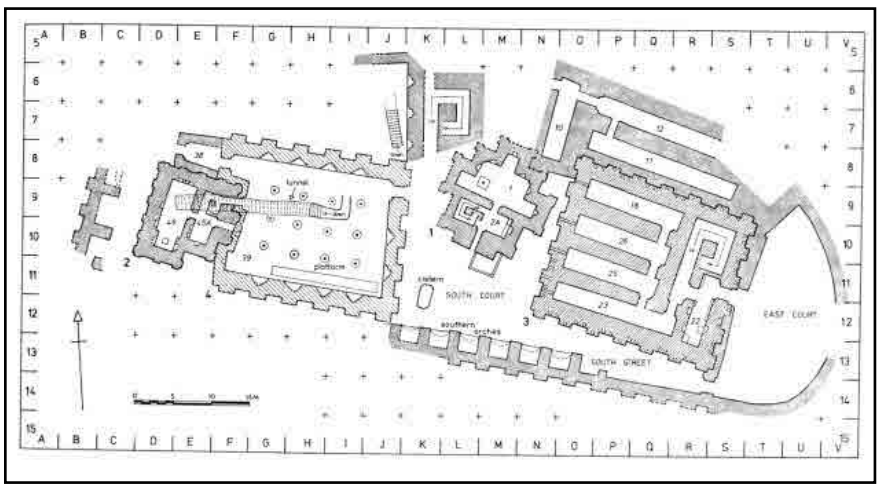
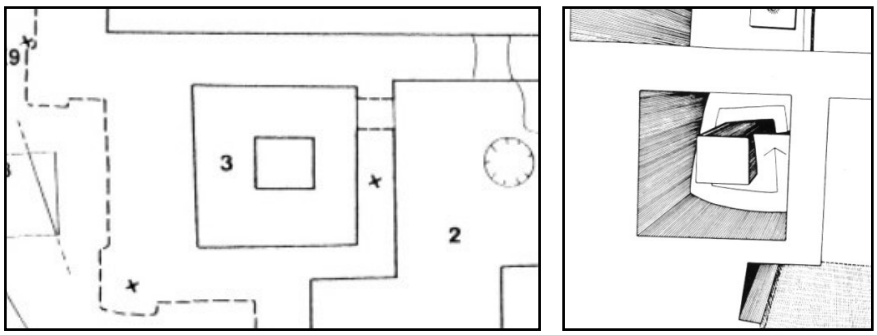


Fig. 7: Map of the architectural remains of the Median settlement in the Nush-i Jan site (Stronach & Roaf, 2007: 55, Fig. 1.9). ▶

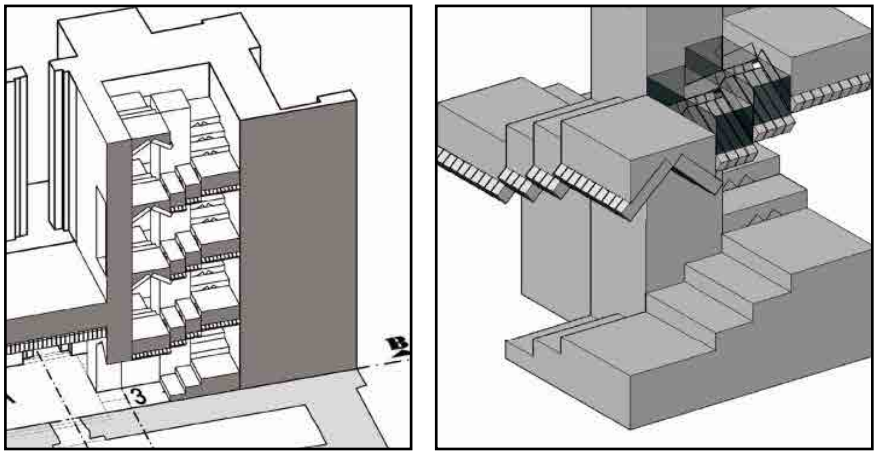
The staircase of the central temple, despite being constructed of mud-brick and covered with a vaulted roof, has been remarkably well preserved thanks to the measures taken by its occupants when they abandoned the site (Stronach & Roaf, 2007: 171). Unlike the examples at Hasanlū and Bābā Jān, the architectural details of this staircase can be thoroughly studied

(Fig. 8). The staircase was situated on the western side of the counter space, to the left of the entrance, and provided access to the second floor of the counter as well as the roof. During excavation, three and a quarter turns of the full staircase, corresponding to a height of 8 meters relative to the counter floor, remained intact.



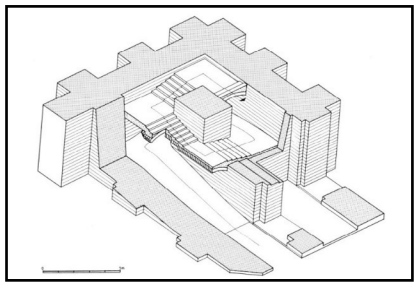
◄ Fig. 8: Isometric map and design of the architectural remains of the spiral staircase discovered in the central temple of the Nush-i Jan site (Stronach & Roaf, 2007: 69, Fig. 2.3; 70, Fig. 2.4).

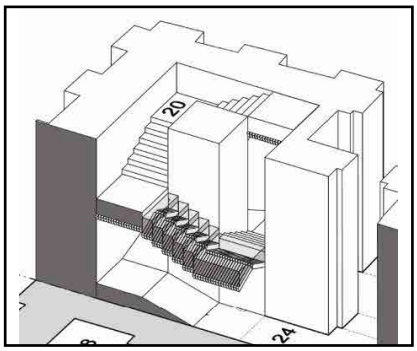
The general structure of the staircases at the Nush-i Jan complex closely resembles the examples from Hasanlū and Bābā Jān, comprising a quadrangular space with a central pillar, with steps ascending counterclockwise around the pillar; however, the construction of the steps and their covering differs from the aforementioned sites. The staircase has a width of 0.80–1.10 meters and revolves around a rectangular central pillar measuring 0.95×1.10 meters. On average, the height of the staircase increases by 50 centimeters per flight of steps, equivalent to 2 meters for a full rotation, resulting in an average slope of approximately 1:4. The staircase covering was constructed using mud-brick battens, which are short and straight, lacking curvature (Fig. 9). The bricks measure 55–60 cm in length, 10–11 cm in width, and 13–14 cm in thickness. The arrangement of these mud-brick arches forms a stepped arched covering, a pattern that is mirrored in the mortar covering above. Specifically, every four consecutive pairs of arches form one step, while the next four pairs at a higher level

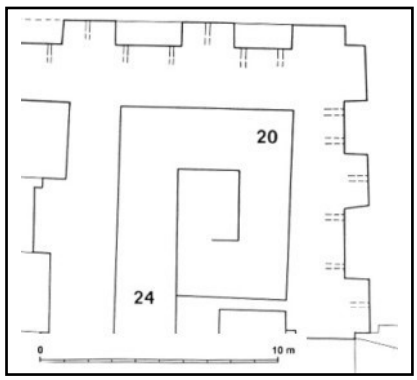


◄ Fig. 9: Isometric drawings of the method of implementing stepped arches in the exposed spiral staircase in the central temple of the Nush-i Jan (Molazadeh and Mohammadian Mansour, 2011: 128, Fig. 12; Ibid: 129, Fig. 14).

▲ Fig. 10. Map of the architectural remains of the spiral staircase discovered in the old western temple in the Nush-i Jan site (Stronach & Roaf, 2007: 93, Fig. 3.1).







▲ Fig. 11. Architectural plan and isometric reconstruction of the spiral staircase in the Fort building at Nush-i Jan (Stronach & Roaf, 2007: 113, Fig. 4.6; Mollazadeh & Mohammadian Mansour, 2011: 132, Fig. 18).

form the subsequent step (Stronach & Roaf, 2007: Fig. 2.4; Ibid: 79; Mollazadeh, 2014: 114).

The staircase of the old western temple (space 44), unlike that of the central temple, is located to the right of the entrance on the northern side of the counter (space 45A) and provided access to the second floor and the roof (Fig. 10). During the excavation, a full turn of this staircase remained intact, reaching a height of 230 cm. Its construction and execution closely resemble those of the central temple, with mud-brick arches measuring 18 cm in width and 9 cm in thickness (Stronach & Roaf, 2007: 100–101). It appears that the staircase of the old western temple was used after the temple's abandonment, with certain modifications, to access the roof of the main columned hall (Stronach & Roaf, 2007: 187; Mollazadeh, 2014: 124). The staircase ascends clockwise around a pillar approximately 2 meters wide. Consequently, the location and direction of rotation of a staircase seem to have been determined by the building plan rather than by a fixed architectural tradition, as the central temple and the old western temple were constructed within a short interval of time. Evidence of five turns of this staircase is preserved, although seven turns would have been required to reach the roof at an approximate height of 640 cm (Mollazadeh & Mohammadian Mansour, 2011: 131).

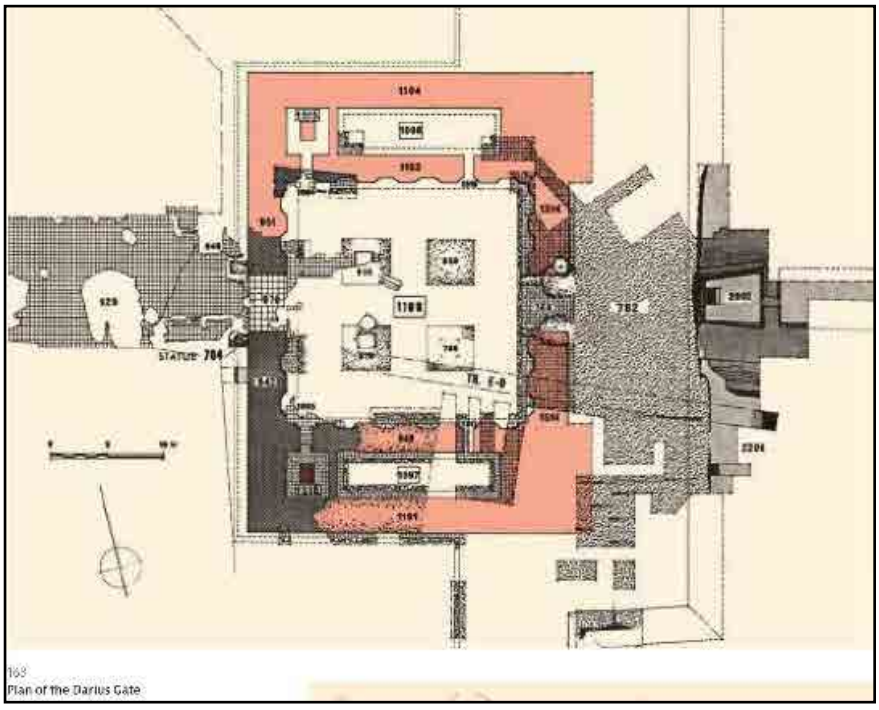
The Fort building (warehouse complex, space 20) also contains a spiral staircase, which appears to have served purposes beyond mere roof access (Fig. 11), providing entry to the second floor of the structure. Like the staircase in the old western temple, it is situated to the right of the entrance and ascends in a clockwise direction. The staircase entrance measures 2 meters in height and just under 2 meters in width. The stair surface initially slopes gradually toward the north, winding around a substantial mud-brick pillar with an area of approximately 2 square meters. Seven full turns were required to reach the upper floor, corresponding to a height of about 6.40 meters. Traces of the arch covering remain on various sides of the central pillar, indicating that the staircase was covered using a stepped arch system composed of mud-brick arches, with each step formed by four opposing arches. Each mud-brick arch measures 18 cm in height and 9 cm in thickness (Stronach & Roaf, 2007: 113, Fig. 4.6).

The large number of spiral staircases and the sophisticated and elaborate methods used to cover them, particularly the arched constructions in several spaces of the Nush-i Jan complex, represent a mature stage in the development of spiral staircases, whose earliest examples are found at Hasanlū. The placement of the staircases within the Median complex, their direction of rotation, dimensions, and other features were

determined by the overall building plan and the functional importance of each structure, although the general layout and construction techniques remained consistent. The use of mud-brick arches to create stepped arched coverings was first identified at this site, and its continuation can be traced in the Achaemenid and Parthian periods (Mollazadeh & Mohammadian Mansour, 2011: 136–137).

Achaemenid period: Susa

With the establishment of the Achaemenid Empire and the emergence of its distinctive architectural tradition, although significant transformations are observable in scale, materials, construction techniques, architectural elements, and decorative programs compared with earlier periods in Iran, certain design principles, most notably the columned hall and columned porch as the central core of Achaemenid architecture, as well as elements such as the spiral staircase, continued, albeit executed on a larger scale and with greater refinement. In the Pasargadae complex, as the earliest architectural ensemble of the Achaemenid period, no spiral staircase has yet been identified, possibly due to the limited preservation of architectural remains. However, well-documented examples have been identified in the gate building of the Susa palace complex, dating to the reign of Darius I (522–486 BC), and in the Shaūr Palace, attributed to the reign of Artaxerxes II (405–359 BC) (Fig. 12–13).



◄ **Fig. 12: Map of the architectural remains of the gate of Darius I discovered at Susa (Ladiray, 2013: Fig. 168).**

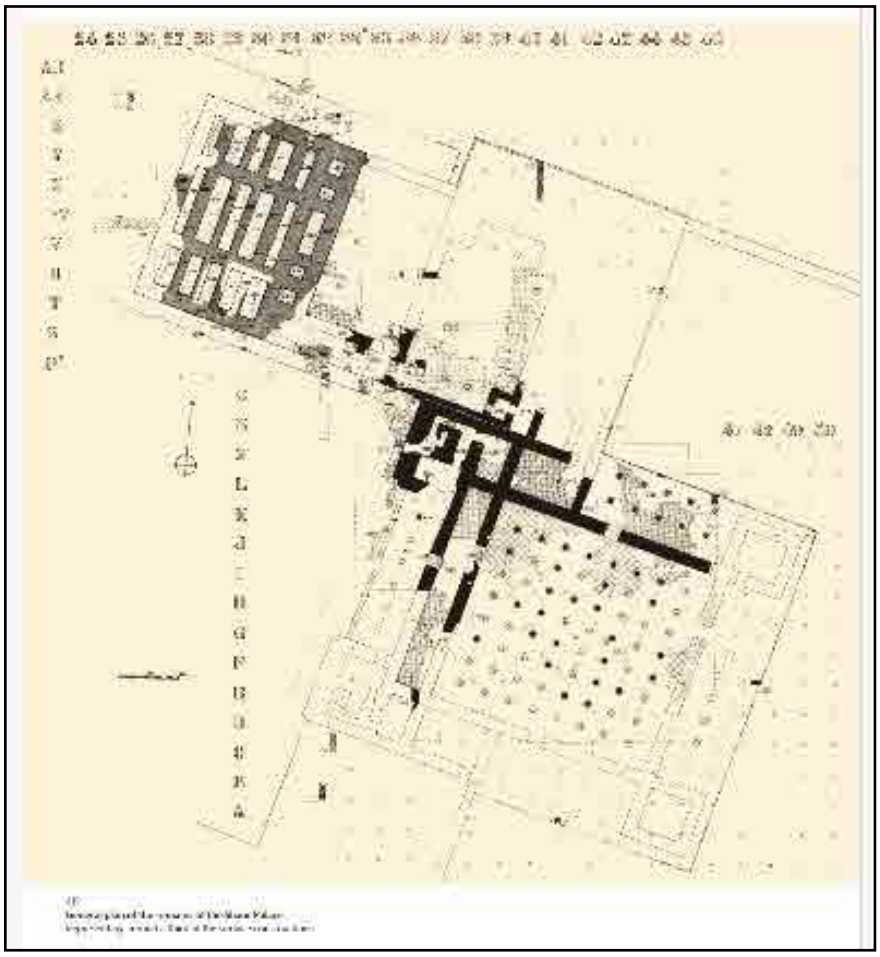
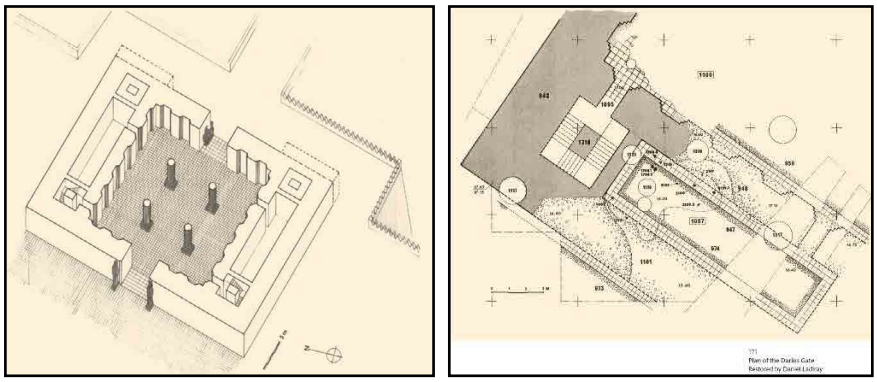


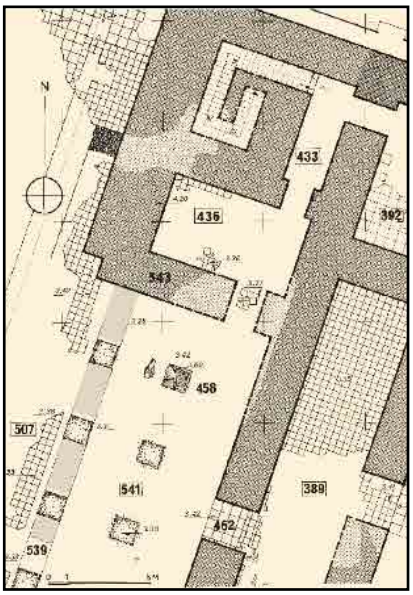
Fig. 13: Map of the architectural remains of the Shaūr palace discovered at Susa (Hesse, 2013: Fig. 419). ▶

The Gate of Darius I: The Gate of Darius I is a freestanding rectangular structure measuring 28×40 meters along an east–west axis. The structure consists of a central hall with four columns measuring 1.21×1.21 meters, flanked by rectangular rooms (14×3.5 meters) on either side, with additional corner rooms that likely housed spiral staircases (possibly in two corners). A trilingual inscription of Xerxes I (XSa) is carved on one of the columns of the central hall, which refers to the completion of the building founded by Darius I (Kent, 1931: 225; 1953: 113; Lecoq, 1997: 261–262). The remains of two spiral staircases have been identified in the northwest and southwest corners of the rooms adjacent to the hall, providing access to the upper floor and the roof (Fig. 14). These staircases are small, cubic spaces with a quadrangular pillar in the center, around which the steps ascended. Only the first step remained at the time of excavation. The other side of the building was severely damaged, and the existence of such staircases on the other side remains uncertain. The steps ascended clockwise around a mud-brick pillar inside a rectangular space and provided access to the upper floors and the roof (Ladiray, 2013: 168, Fig. 168, 169 & 171).



◄ Fig. 14: Lef: Spiral staircase discovered in the gate of Darius I, Susa (Ladiray, 2013: 170, Fig. 171) and right: isometric drawing (Ibid: 169, Fig. 169).

Shaūr Palace Complex: The remains of the Shaūr Palace Complex, dating to the reign of Artaxerxes II (404–359 BC), have been excavated on the west bank of the Shaūr River, approximately 50 meters from the Apadana of Darius I, and are located only a few meters above the plain; the complex derives its name from the adjacent river. Shaūr Palace comprises a complex consisting of a large columned hall and residential and recreational buildings within an area measuring 150×220 meters. These remains were excavated in the 1970s by Remy Boucharlat and Audran Labrousse; the site plan was subsequently prepared and completed by Albert Hesse. Based on the reconstructed map, the Shaūr Palace Complex consisted of three main buildings, courtyards or open spaces, and other destroyed buildings. The main columned hall (Building I) measures 34.6×37.5 meters, and its plan is similar to that of the Apadana of Susa, with its central ceiling resting on eight rows of eight columns. In the middle of each side of this hall, there was a columned porch. On both sides of the western columned porch, there were corner towers, of which only remains in the northwest part have survived. Inside these towers, a room and a spiral staircase were constructed, accessible through the western porch (Fig. 15). The direction of movement of this staircase was counterclockwise, opposite to the clockwise examples previously discussed (Hesse, 2013: 373–403). No other spiral staircases have been identified in the main palaces of Susa or the Persepolis complex, possibly due to the extensive destruction of these structures. It seems that with the expansion of architectural scale and the need to facilitate access to large and monumental buildings, broad, conventional staircases with landings were generally preferred, while spiral staircases, more suitable for confined spaces, were used less frequently.



▲ Fig. 15: Spiral staircase discovered in the western porch of the Shaūr palace, Susa (Hesse, 2013: 382, Fig. 426).

Parthian period, Qūmis site: Relatively few architectural remains from the approximately five-hundred-year Parthian period survive on the Iranian Plateau, and very little information is available regarding the form and architectural characteristics of the staircases used during this period.

The only identified examples from this period are from the Qūmis site, which was excavated by Hansman between 1967 and 1972 AD. Three religious buildings have been discovered at this site, which are particularly well-preserved owing to their accumulation and burial during the Parthian period (Hansman, 1968; Hansman et al., 1970; Hansman & Stronach, 1974) (Fig. 16). The plan, architectural details, and function of these buildings are very similar to the central temple of Nush-i Jan from the Median period (Mollazadeh, 2011: 124). However, the staircase, despite certain similarities, particularly in the execution of the arch, exhibits notable differences from the spiral types of earlier periods. The discovered staircase at Qūmis is located in a rectangular space with a central wall and employs a stepped arch to create a sloping passage providing access to the second floor and the roof; its direction of rotation is clockwise, contrary to some of the earlier examples discussed (Fig. 17). Despite the limited number of identified spiral staircases from this period, and considering the continued use of such staircases in the Sassanid period, it is likely that their use remained common during the Parthian era as well.

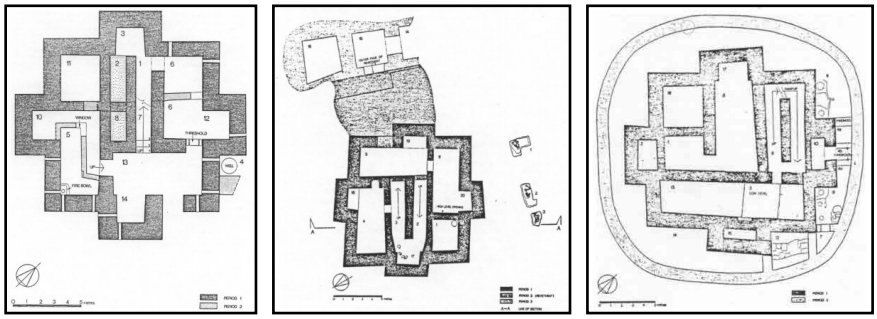


Fig. 16: Left: Buildings with spiral staircases discovered at Qūmis, site 4 (Hansman & Stronach, 1974: 9, Fig. 1); center: site 7 (Ibid: 13, Fig. 2 b); right: site 13 (Ibid: 15, Fig. 3). ▶

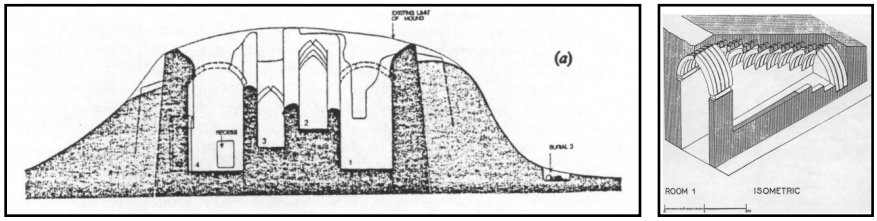


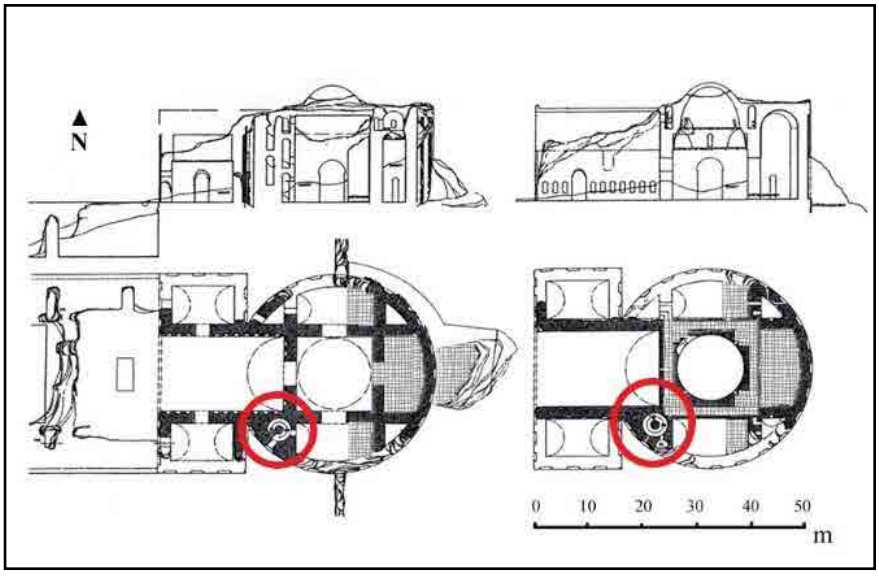
Fig. 17: Comparative illustration of the arched roofing technique employed in two excavated structures at Qūmis; left: longitudinal section of Site 7 (Hansman & Stronach, 1974: 13, Fig. 2a); right: isometric plan of Room 1, Site 4 (Hansman et al., 1970: 50, Fig. 10). ▶

Sassanid building at Firuzabad

Firuzabad, the first seat of Ardašir I of the Sassanid dynasty (224–240 AD) (attributed to the early Sassanid period, though some scholars assign parts of it to the late Parthian period), preserves the architectural remains of two spiral staircases and another distinctive example. These remains not only attest to the continued and expanded use of this architectural element into the Sassanid period but also illustrate a transitional phase from spiral staircases with a cubic external form to those with a circular plan. The first structure is the Firuzabad Tower, a monumental edifice

originally measuring 18×18 meters and approximately 40 meters in height. It comprised a central cubic core, a staircase winding around the central pillar, an outer wall, and a room or space at the uppermost level (Hoff, 1987: 91). Today, apart from the remains of the central core, the other components, including the spiral staircase, have not survived (Huff, 1989, fig. 5). This tower, located at the focal point of the city of Firuzabad and likely influential in the circular urban design of the city, is roughly contemporary with the Trajan's column (113 AD) and the Column of Marcus Aurelius (196 AD) in Rome. Unlike the Firuzabad Tower, however, these Roman monuments were constructed with circular shafts and on a smaller scale, and they are regarded as among the earliest Roman structures incorporating internal spiral staircases.

Another building is the Qal'a-ye Dukhtar of Firuzabad, constructed on a mountain overlooking the Firuzabad plain. This palace-fortress, covering approximately 500 square meters, was built by Ardašir I in the early years of his reign, probably prior to the final overthrow of the Parthian dynasty. The complex was erected on a sloping mountainside across three distinct levels. Its principal section includes a large porch and a domed hall situated behind it. Surrounding the porch and hall was a corridor, with rooms on the second floor accessible via a spiral staircase with a circular plan (Herrmann, 1994: 93; Huff, 2005: 373–374). This example represents the earliest identified instance of a spiral staircase with a fully circular plan in Iranian architecture (Fig. 18).



◄ **Fig. 18: Plans and sections of the Qal'a-ye Dukhtar of Firuzabad; discovered spiral staircase (marked in red) (Huff, 2005).**

The third structure is the palace of Ardašir I at Firuzabad, also referred to as the "Ataškada" building (Fig. 19). Erected on a plain overlooking a lake, this complex comprises two principal divisions, generally interpreted

as reception (outer) and residential (inner) sections. The reception, or main, section consists of a large porch flanked by side pavilions, with three domed chambers situated behind them. A surrounding corridor and a series of residential rooms, likely intended for members of the royal household, were arranged on the upper level around the porch and domed halls. Access to this upper floor was provided by a substantial spiral staircase positioned at the center of the northwest side of the complex. Unlike the example at Qal'a-ye Dukhtar, this staircase was designed and executed with a square plan (Huff, 2005: 373–374) (Fig. 20). This contrast may be attributed to spatial constraints and the more overtly defensive character of Qal'a-ye Dukhtar, which likely necessitated a more compact, circular configuration. The principal construction materials employed in Sasanian architecture were rubble stone, occasionally hewn, and gypsum mortar, while the staircases were roofed with vaulted coverings.

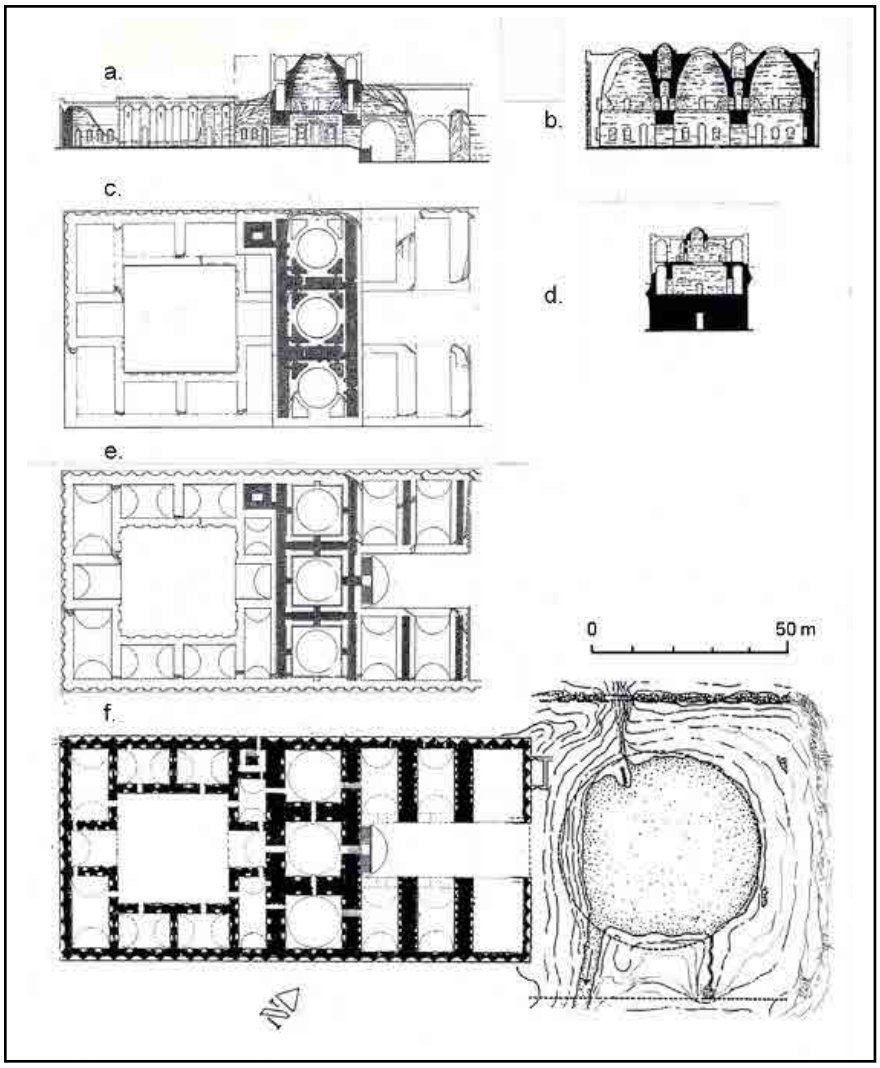
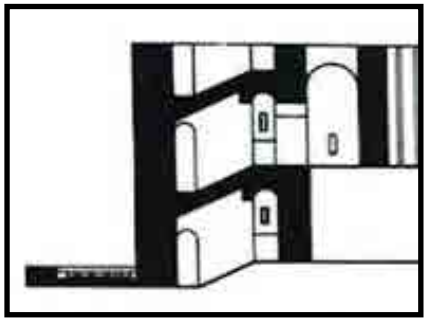
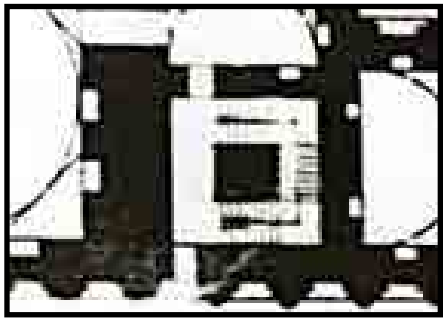


Fig. 19: Sections and plans of the Firuzabad palace (Michell & Eaton, 1992). ▶





◄ Fig. 20: Discovered spiral staircase in the Firuzabad palace; Left: plan (Michell & Eaton, 1992) & Right: Longitudinal section (Ibid).

Table 1: Comparative architectural analysis of spiral staircase typologies across the historical periods of the Iranian Plateau (Authors, 2025).▼

Architectural features / Site	Level	Chronology	Building	Location in the building	Direction
Hasanlū	V	Iron Age I (1450-1250 BC.)	Residential House	Left side of the counter	Clockwise
	IVC	Iron Age II (1250-1050 BC.)	BB II	Right side of the counter	Counterclockwise
			BB III	Right side of the counter	
			BB IV E	Left side of the counter	
			BB V	Right side of the counter	
	IVB	Iron Age II (1050-800 BC.)	BB I E	Right side of the counter	
			BB I W	Left side of the counter	
			BB V-IV	Right side of the counter	
Bābā jān	III	Late Iron Age II	Fort	Right side of the counter	Counterclockwise
Nish-i jān	-	Iron Age III (800-650 BC.)	Central Temple	Left side of the counter	Counterclockwise
			Old Western Temple	Right side of the counter	Clockwise
			Fort		
Susa	-	Darius I (Around 518 BC.)	Palace-gate (Probably 2 cases)	No counter	Clockwise northwest staircase
					Southwest Staircase Counterclockwise
		Artaxerxes II (404-359 BC.)	Shaūr Palace		Counterclockwise
Qūmis	-	Parthian (247 BC. – 224 AD.)	Site 4	No counter	Clockwise
			Site 7		
			Site 13		
Firuzabad	-	Ardašir I (224 – 240 AD.)	Qal'a-ye Dukhtar	No counter	Counterclockwise
			Ataškada or Palace	Right Side of The Counter	Clockwise

Conclusion

The widespread adoption of flat roofs constructed of straw and mud in the Middle East was closely associated with the functional significance of rooftops and upper stories. Access to upper floors, often the principal residential spaces, together with the need to utilize rooftops for a range of domestic activities and to undertake periodic maintenance and renewal of roof coverings, necessitated the provision of stable and permanent means of vertical circulation. By contrast, in regions characterized by humid climates where truss or gabled roofs predominated, or in hot and arid areas where vaulted and domed roofing systems were common, rooftops generally lacked comparable functional importance. Consequently, the construction of fixed and substantial structural access to the roof was not essential. In such contexts, wooden staircases or temporary structural solutions were often sufficient for reaching upper levels. In the ancient Near East, however, the functional importance of flat roofs created early and sustained demand for durable vertical access systems. From the earliest phases of architectural development, particularly with the expansion in building scale during the fourth and third millennia BC, as indicated by archaeological evidence, various forms of access to upper stories and rooftops were devised and implemented. Given the pioneering role of Mesopotamia and northern Syria in numerous civilizational and architectural innovations, it is reasonable to assume that these regions were also early innovators in the development of the staircases under consideration.

The populations of northwestern Iran in the late second and early first millennia BC, identified with Hurrian groups, maintained cultural affinities and sustained interactions with northern Syria and Mesopotamia. Through such contacts, certain architectural concepts and construction techniques were likely transmitted. Nevertheless, architectural form is ultimately conditioned by environmental context. The general architectural configuration of northwestern Iran, which persisted into the Median and Achaemenid periods, emphasized columned halls, porches, and lateral subsidiary spaces—features not characteristic of Mesopotamian architecture. In this light, it is plausible that this architectural scheme, together with the development of spiral staircases, emerged and evolved independently in the northwestern Iranian context before disseminating to other regions of western Iran. The example discovered in Level V at Hasanlū appears to represent the earliest known spiral staircase. During this period, Hasanlū witnessed the consolidation of a ruling elite and the emergence of an associated architectural program. As Huff has demonstrated in his

study of elite residential architecture, the large halls and adjacent ground-floor spaces were devoted to reception and service functions, whereas the second-floor spaces were allocated to the private quarters of the ruling family. These elevated residential spaces offered practical advantages, including improved protection from ground-level humidity, dust, and pollution, as well as enhanced ventilation; they were also visually and functionally connected to the reception halls through architectural openings (Huff, 2005: 372–374). In view of the functional and symbolic importance of the upper story, as well as the necessity of roof access, the provision of secure and permanent vertical circulation was essential. Such staircases may therefore be understood as integral components of elite architectural planning, shaped in accordance with the environmental conditions of the Zagros region and in continuity with other local architectural traditions of the period.

The architectural schemes developed in northwestern Iran likely spread to western Iran through interregional political and cultural interactions among local polities during the ninth century BC, subsequently undergoing modifications in the course of their evolution. This process is particularly evident in the Median period at the Nush-i Jan site, where the use of stepped arches constructed with mud-brick voussoirs in the roofing of spiral staircases appears to represent a technical innovation. It has been suggested that this technique may reflect constructional traditions carried by Iranian groups from their earlier Central Asian homelands (Mollazadeh, 2011: 135). This hypothesis gains relevance when contrasted with the longstanding architectural practices of the Zagros region, where flat roofs supported by wooden beams had predominated since prehistoric times. Given the ready availability of timber, the relative economy of beam construction, its technical simplicity, and the functional versatility afforded by flat roofs, such solutions were environmentally and materially well suited to the region.

During the Achaemenid period, notwithstanding the significant enlargement of architectural scale and transformations in design principles, construction techniques, and materials, spiral staircases continued to be employed. However, the monumental expansion of architectural programs and the relative absence of spatial constraints favored the widespread adoption of broad, straight staircases designed to facilitate ceremonial and practical movement. The staircases constructed within the corner towers of the buildings conventionally identified as the Apadana at Persepolis and Susa exemplify this approach.

Unfortunately, relatively few architectural remains from the Parthian period have survived with sufficient detail to permit thorough study, and the present investigation has not identified clearly documented examples from this era. Nevertheless, considering that the spiral staircases attributed to the reign of Ardašir I at the beginning of the Sassanid period are chronologically close to the final phase of Parthian rule, it is reasonable to infer that the tradition of constructing spiral staircases persisted throughout the Parthian period and continued into the Sassanid era. This interpretation is further supported by the broader observation that Sassanid architecture constitutes, in many respects, a direct and natural continuation of Parthian architectural traditions.

It can be asserted that the overall configuration of spiral staircases, including the general layout and the direction of rotation, remained largely consistent throughout the period under study (circa 1450 BC to the third century AD) (Table 1). Nevertheless, towards the end of this timeframe, the emergence of a spiral staircase with a circular plan, as exemplified by the Qal'a-ye Dukhtar of Firuzabad, marks a notable innovation, likely motivated by spatial constraints and potentially influenced by Roman architectural practices. In all identifiable cases, the rotation of the steps is counterclockwise. This orientation appears to reflect a functional relationship with the design of the counter space, the placement of the staircase entrance, and—most importantly—a right-sided movement pattern, which may represent an ancient architectural convention that has persisted to the present day. With respect to construction materials and techniques, the studied staircases exhibit a clear correspondence with environmental conditions and prevailing cultural practices. During the Iron Age through the Achaemenid period, mud-brick constituted the principal building material; brick was occasionally employed in the foundations of Achaemenid examples, while stone and plaster were used in Sassanian constructions. The dimensions of mud-bricks varied across periods: in Hasanlū, large square bricks measuring approximately 12×45×45 cm were employed; in the Median period, rectangular mud-bricks of approximately 10×25×42 cm were used, often complemented by mud-brick arches to cover the staircases; and in the Achaemenid period, mud-bricks or, in some instances, square bricks measuring roughly 10×33×33 cm were utilized.

Precise information regarding the covering of the Hasanlū and Bābā jān staircases remains unavailable. It appears that these coverings were executed either using mud-brick arches or with the support of small wooden and mud-brick beams. In contrast, staircases from the Median,

Achaemenid, and Sassanian periods consistently employed arched coverings. A key conclusion of this study is the extensive chronological depth of spiral staircase construction in Iran, which predates comparable Western examples. As noted in the introduction, many sources identify the staircase of the Temple of Selinunte in Italy, dated to 480 BC, as the earliest known spiral staircase, followed much later by the staircase within Trajan's Column, constructed in 113 AD. Iranian examples, however, can be traced to approximately a millennium earlier. It should be emphasized that the Roman instances represent the earliest spiral staircases with a circular plan, which likely evolved from earlier examples featuring a square configuration.

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Author Contributions

All authors have had equal participation.

Conflict of Interest

The Authors, while observing publication ethics in referencing, declare the absence of conflict of interest.

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روند شکل‌گیری و گسترش راه‌پلّه مارپیچی‌شکل در معماری پیش از اسلام، ایران

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چکیده

معماری ایران با سابقهٔ حدود ده‌هزار سال در زمینه‌های مختلف ساختاری، فنّی و هنری پیش‌گام و نوآور بوده و شاهکارهای ارزشمندی را در دوران تاریخی و اسلامی به جهان عرضه کرده است. باوجود پیشینهٔ پژوهشی حدود ۱۰۰ساله جنبه‌های مختلف معماری سنّتی ایران، هنوز، ناگفته‌ها و جزئیات زیادی وجود دارد که شوربختانه به‌دلیل فقدان مدارک و اسناد تاریخی و نیز بقایای معماری اندک برجا مانده، موردمطالعه و روشن‌گری قرار نگرفته است. معماری ایران در زمینه‌های ساختاری، فنّی و هنری در جهان، پیش‌گام و نوآور بوده و شاهکارهای ارزشمندی در دوران تاریخی عرضه کرده است. باوجود این موضوع، در ارتباط با جنبه‌های مختلف آن، نادانسته‌ها و ابهامات زیادی وجود دارد. مباحث مربوط به طرّاحی، اجرا، فنون و عناصر خاصّ معماری از این‌جمله است. در این ارتباط، باوجود پیش‌گامی ایران در زمینهٔ طرّاحی و اجرای نخستین راه‌پلّه‌های مارپیچی‌شکل و نیز نقش مهمّ این عنصر در معماری دوران تاریخی، پژوهشی علمی صورت نگرفته و منشأ، روند شکل‌گیری و سیر تکامل آن مشخّص نیست. پژوهش حاضر با تمرکز بر این ابهامات، با تکیه‌بر منابع و داده‌های باستان‌شناسی، به شیوهٔ توصیفی-تحلیلی تلاش کرده روشنگر نقش و جایگاه ایران در زمینهٔ ساخت راه‌پلّه‌های مارپیچی‌شکل باشد. براساس پژوهش‌های انجام‌شده و باتوجه به اشاره منابع لاتین به نخستین نمونهٔ شناسایی‌شده راه‌پلّه مارپیچی‌شکل در ایتالیا مربوط به سال ۴۸۰پ.م.، نخستین نمونهٔ شناسایی‌شده در ایران در حسنلوی V بسیار قدیمی‌تر و مربوط به اواخر هزارهٔ دوّم پیش‌ازمیلاد بوده و روند شکل‌گیری و گسترش استفاده از آن‌ها در معماری هزارهٔ اوّل پیش‌ازمیلاد شمال‌غرب در حسنلوی V و IV، در غرب ایران در باباجان III و استقرار اصلی ماد در محوطهٔ نوشیجان و تداوم آن در دورهٔ هخامنشی در محوطهٔ شوش، در دورهٔ اشکانی در محوطهٔ قومس و در دورهٔ ساسانی در قلعه‌دختر و کاخ اردشیر یکم در فیروزآباد قابل مطالعه و پیگیری است.

کلیدواژگان: راه‌پلّه مارپیچی، معماری عصر آهن ایران، معماری ماد، شوش، حسنلو.

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