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پژوهش‌های باستان‌شناسی ایران
Bu-Ali Sin University
Iranian Scientific Archaeological Association
پژوهش‌های باستان‌شناسی ایران
PAZHOHESH-HA-YE BASTANSHENASI IRAN
P. ISSN: 2345-5225 & E. ISSN: 2345-5500
Homepage: https://nbsh.basu.ac.ir/
Vol. 13, No. 37, Summer 2023

Study of Rendeh Asbad Complex, Sistan[1]
(Architectural Remains of the Largest Flour-Production Facilities of the Eastern Iran in the Mid-Islamic Centuries)

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https://dx.doi.org/10.22084/NB.2023.26798.2519
Received: 2022/09/02; Accepted: 2023/03/19
Type of Article: **Research**
Pp: 247-271

Abstract
During his lifetime, the Human has always been in a constant interaction with the environment, and the growth and development of human civilization have taken place in the context of the natural environment. Meanwhile, a manifestation of humans's alignment with their surrounding environment is the technology of using natural phenomena in different regions. One of these technologies is the construction and operation of Persian windmills (Asbads), the earliest example of which has found to belong to the Iranian civilization to this day. Sistan is thought to be the place where Asbads were invented for the first time, and today numerous remains of historical Asbads are found in this region. Although the best-known windmills of Sistan are those of Hozdar complex, there are other Asbads in Rendeh region of Sistan, some of which can be regarded as the most representative examples of Iranian windmills. Unfortunately, despite the significance of this issue, no comprehensive research has been conducted on these windmills so far and questions regarding their age, architectural structure and typology as well as the position of the region during its lifetime have remained unanswered. The authors of the present paper have, therefore, made a comprehensive identification of this complex relying on field studies and archaeological surveys; and subsequently, using a descriptive-analytical method, they have extensively studied the architectural structure of windmills and other monuments of Rendeh complex. The results suggest that the Asbads and the sites of Rendeh complex are older than other windmills of Hozdar, dating back to the 6th-9th centuries AH. This collection includes the greatest number of windmills belonging to the mid-Islamic centuries, thus making this the largest flour production complex of Sistan. Among them, a windmill known as "Se Pareh" is the biggest known Asbad in eastern Iran, the architectural type and style of which have continued in the Safavid windmills of Hozdar during the subsequent periods by removing the side courtyard and its surrounding storage rooms. It was also found that this windmill is the oldest example of twin-windmills in Iran.

Keywords: Asbad, Architectural Survey, Mid-Islamic Centuries, Rendeh, Sistan.

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Citations: Alaei Moghadam, J. & Mousavi Haji, S. R., (2023). "Study of Rendeh Asbad Complex, Sistan (Architectural Remains of the Largest Flour-Production Facilities of the Eastern Iran in the Mid-Islamic Centuries)". *Pazhoheshha-ye Bastan Shenasi Iran,* 13(37): 271-247. https://dx.doi.org/10.22084/NB.2023.26798.2519
Homepage of this Article: https://nbsh.basu.ac.ir/article_5322.html?lang=en

PAZHOHESH-HA-YE BASTANSHENASI IRAN
Archaeological Researches of Iran
Journal of Department of Archaeology, Faculty of Art and Architecture, Bu-Ali Sina University, Hamadan, Iran.

Introduction

No information is available regarding the first windmills and the time they emerged, some historians, however, attribute the origin of Asbads to a time around 200 BC (Sur al-Aghalim 1974: 9). The earliest source mentioning Asbads is the History of Prophets and Kings or Tarikh al-Tabari by Muhammad ibn Jarir al-Tabari (224-310 AH) (Yarshater 1999: 89-90). Ibn Khaldun's "The Muqaddimah: An introduction to history" is the oldest known source mentioning the existence of windmills prior to Arabs invasion (Ibn Khaldun, 2016: 552).

Many think of the Great Sistan as the origin of windmills and even today the oldest windmill can be found in this region. In Ibn Khordadbeh's Masalik w'al-Mamalik, in a section in which he is explaining about Sajestan, he mentions, "it is an extensive province, some believe that Sajestan is an area the center of which is Zaranj, where the wind never stops and the mills in that region are windmills" (Ibn Khordadbeh, 1992: 54). In Meadows of Gold and Mines of Gems, belonging to the fourth century AH, it has been stated about Sistan that "The wind blowing there spins the mills, draws water from wells and irrigates the gardens," (Masoudi, 1965: 204). In Ahsan al-Taqasim fi Ma'arfa al-Aqalim, "the windmills of Sakestan Poushang of Zaranj fortress" have been introduced as the wonders of the Orient (Muqadasi, 1982: 488). Ibn Ḥawqal (1966: 153) also points to the existence of windmills for flour production in Sistan, stating, "There is always a constant strong wind in Sistan and for the same reason windmills have been constructed there to produce flour..." The presence of Asbads in Sistan and other applications of wind energy in that region have also been mentioned in Ashkal al-Alam (Jeyhani, 1989: 162). Other sources such as Al-Masalik Wa'l-Mamalik (Istakhri, 1961: 194), Asar al-Ibad Wa Akhbar al-Bilad (Ghazvini, 1987: 36), Hudud al-Alam Men Mashrigh Il al-Maghrib (anonymous, 1993: 319), Mu'jam al-Buldan (Hamawi, 1995: 190), Taghvim al-Buldan (Abu al-Fada, 2007: 391) have also pointed to the existence of Asbads in Sistan. In History of Sistan, the author has talked about the wonders of this region, "…and they establish mills operating with wind to make four…and there is another city which is entirely independent and does not rely on any other cities," (anonymous, 2002: 57). The existence of windmills has also been mentioned in Ihya al-Muluk (Malik Shah Hussein, 1965: 13). In addition to historical sources, in archaeological surveys led by Mousavi Haji and Mehrafarin (2008), resulting in the identification of more than 1670 ancient places in different regions of Sistan, there have been references to the existence of windmill ruins.

Unfortunately, despite the significance of Asbads in Sistan region, both in terms of having been mentioned in historical sources and in terms of age and architectural style, there is little research about them and most of the studies conducted on Persian windmills are focused on Khorasan area and other western regions of Afghanistan. On the other hand, a couple of studies, existing about Sistan windmills, are mostly centered on several Safavid windmills in Hozdar region, whereas the windmills in other areas of Sistan are very noticeable in terms of age and typical prominent architectural features. One of the regions, in which the remains of Asbds can be found, is the Hozdar. This region is nowadays located in northeast of Zabol and west of Hirmand cities. There are remains of several ruin buildings, including Asbads, castles, mansions, and a considerable number of large hills and mounds, on some of which traces of walls and plans of old buildings can still be recognized. Despite the high significance of the region and the remains of a large windmill in it, no consistent and specific archaeological and historical study has been conducted on it and the questions regarding the age of these windmills, their architectural structure and study of their styles as well as their position in the region in their lifetime have remained unanswered and this issue is totally ambiguous. This has caused significant parts of this region to be destroyed during the last decade. Accordingly, it can be stated that one of the research priorities of the region should be the study of these remains; the authors of the current research have, therefore, engaged in an investigation of this region and its architectural remains so that in addition to a thorough and comprehensive recognition of the above-mentioned remains, their age, function and position during their lifetime could be determined.

Research questions and hypotheses: This research is based on three questions:

- According to the existing architectural remains, what buildings and functions does Rendeh complex include?

- Chronologically, what historical period does this complex belong to?

- How could the position of this complex at the time of emergence and existence in Sistan region be evaluated?

Accordingly, this research is based on the following hypotheses:

1- Rendeh complex, as a part of a satellite town of the old city of Zahedan, Dar al-Hukoma (government seat) of Sistan in the mid-Islamic eras, was a residential-manufacturing area in which various residential, manufacturing, supervisory and governmental buildings were constructed.

2- According to the cultural materials obtained, architectural style and

its connection with the old city of Zahedan, this complex belongs to the mid-Islamic centuries.

3- The Rendeh complex must be conceived as the most important flour production in Sistan during the mid-Islamic centuries.

The existence of the greatest number of windmills and the largest windmill of Sistan confirms this argument. The operation of windmills in the region has led to the increasing growth and prosperity as well as the formation of high buildings such as Arg-e Mir Jamal and Talar Mansion.

Research Methodology

This research is fundamental in terms of nature, and historical and descriptive-analytical in terms of methodology. The information required for this research is collected through a field study of the area, examination of written sources, as well as the results of studies and research conducted on this subject matter. As part of this study, for the first time, an independent and comprehensive archaeological and architectural study on the structure of the region was carried out, and in addition to field surveys, all the works and remains discovered during the study were recorded, planned, and analyzed in terms of styles and pathology. With reference to the information obtained, a comprehensive identification and data analysis of this collection are performed for the first time in order to meet the research objectives and provide an answer to the research questions.

Research Background

Despite the high importance of Asbad buildings, there is little research about them and most of the studies have focused on windmills in Khorasan region, particularly Nashtifan (Bahadori and Ghahramani, 2013; Darvishi et al., 2016; Bolanakhtar, 2009; Khezri and Imani, 2009; Pashaei Kamali, 2019), Khwaf (Naderi 1977; Pishyar et al., 2014) and Nehbandan (Mousavinehad and Taya, 2014) windmills and research on Sistan windmills just includes a few number of brief studies, the results of which published in a couple of articles.

There is an interesting report from 1897 by Brazier-Creagh, in which he has pointed to 36 Persian windmills existing in Sistan in the text of the reports and 43 windmills in the report table (Brazier-Creagh, 1897: 18-41). Edward Yate (1986: 71) is also another person who has mentioned Sistan windmills in his report. J. P. Tate is one of the people that have provided a detailed description of different areas and some ancient works of Sistan.

In a few pages of chapter 12 of Sistan he describes Rendeh region, but without any mention to the windmills (1983: 104-106).

In 2001, a booklet entitled, "Sistan, the Origin of Windmills in the World" was published by the research group of Geography Department at University of Zabol in 25 pages and merely introduced the Asbad building (without mentioning any specific Asbad) (Heidari Mokarar et al., 2001).

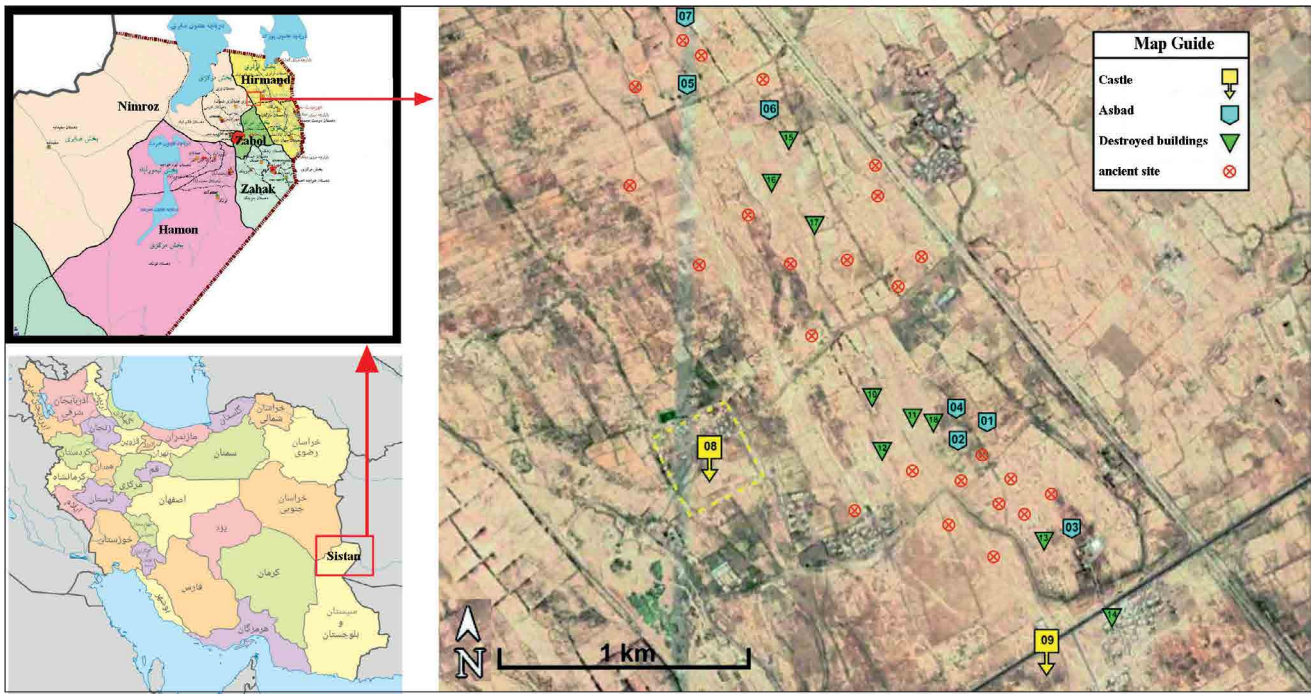
In 2011, Mahdavinejad in collaboration with Bamanian and Mashayekhi, in an article called, "Asbads, the Oldest Windmills in the World" pointed to Sistan Asbads very briefly (Mahdavinejad et al., 2011: 50-52). Despite being a good research study, the afore-said authors have mistakenly attributed the image of a circular twin Asbad to Sistan which in fact does not belong to this region. In the same year, Nima Etehadi studied and introduced Qala Machi windmill of Hozdar in an article entitled "Sistan windmills, a model derived from sustainable architecture" (Etehadi, 2011). Gholami et al., (2017: 3-18) are also among the people who have carried out studies on Machi windmill and published an article on this issue. Another work performed in this area is the analysis of the effect of construction technology and craftsman skills on the formation of Sistan Asbads that was presented in the 5th International Congress on Civil Engineering Architecture and Urban Development (Kazemi and Vali Beigi, 2016: 1-10).

Among the most recent studies conducted on Sistan windmills, research by Moselm Mishmast can be mentioned that has investigated different types of windmills in Iran as well as the technology of producing millstones and published his studies in a few articles (Mishmastnehi, 2015: 391; Mishmastnehi and Bernbeck, 2015: 89-94; Mishmastnehi, et al., 2021: 4-7). Unfortunately, they have also mentioned the name of Rendeh Asbad just in one article with no explanation .

As mentioned so far, unfortunately, no independent and comprehensive scientific research has been conducted on Rendeh region and its windmills and the information on this issue is also limited to some brief references (by just mentioning the names and a few sentences explaining about them) in Mishmast's research and also registering the Rendeh region (with no direct mention of the windmill buildings) as one of the places in the Islamic eras in the plan for archaeological survey of the extensive plain of Sistan (Mousavi Haji and Mehrafarin, 2008: 1315). Hence, the present research is the first and most comprehensive study conducted on Rendeh region and its windmills, in which different architectural and functional aspects of this complex and its status in settlement system of the mid-Islamic centuries have been addressed.

Rendeh complex is located 14 km west of the city of Hirmand and 17 km northeast of Zabol. This collection includes the remains of more than 42 small and large buildings, hills and mounds, covering an area of more than four square kilometers (Fig. 1). It should be noted that according to the studies by Mousavi Haji to determine site boundaries and identify the limits of the Zahedan Kohneh's Rabaz (Mousavi Haji, 2009), it was found that Rendeh complex had been located near the northern boundary of Rabaz in this city.

According to the current situation, the different places in the Rendeh complex are divided into two categories with and without architecture. Places with architecture include windmills, citadels, mansions and remains of small buildings.



▲ Fig. 1: Location and type of works identified in Rendeh complex, Sistan (Authors, 2021).

A. Asbads: The most important and prominent archaeological works in Rendeh complex are the remains of Asbads. In the current situation, the remains and traces of Asbads are found in seven places, some of which are completely recognizable and some are severely destroyed.

Place 1 (SePareh Asbad): the most important and best-known building in Rendeh complex includes the ruins of a twin Asbad locally known as "Se Pareh". The building mentioned includes two connected windmills, a southern courtyard and the rooms surrounding the courtyard. This complex is 1387 m2 in area (with maximum length of 47 m and maximum width of 27 m). The main building of the Asbad is 21 meters long in the north-west-

south-east direction, which is divided into two parts, eastern and western, by a wall (Fig. 2).

Fig. 1: SePareh Asbad, Rendeh from the north (Authors, 2021). ▶

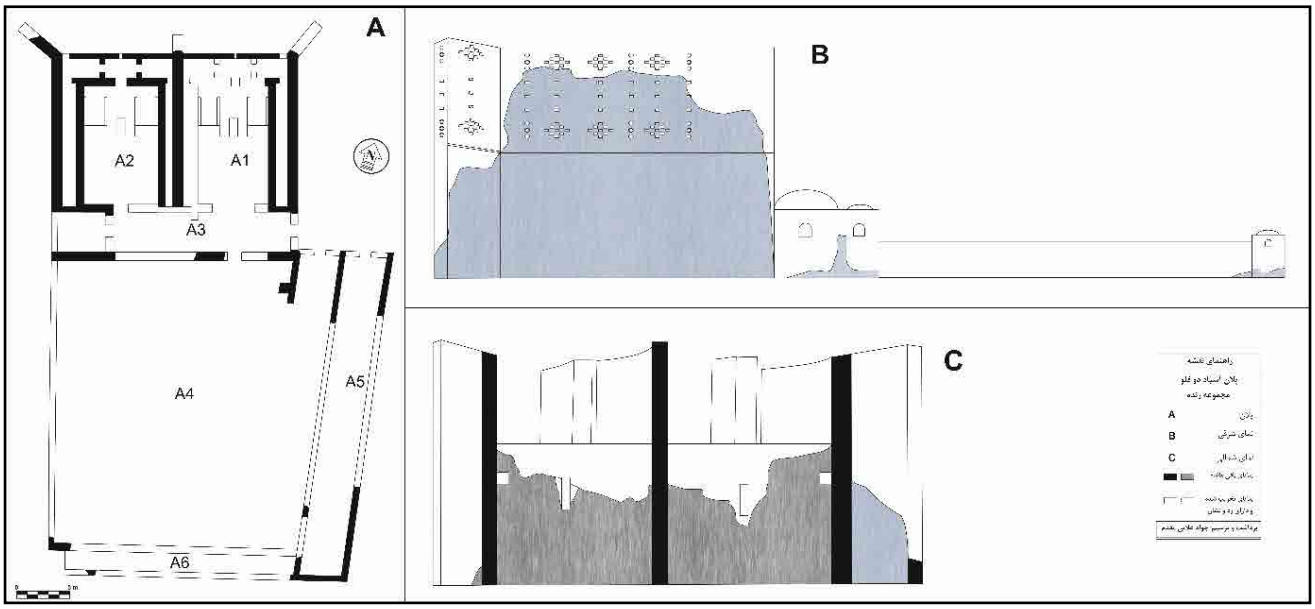
The entrance, which is 120 cm long, is located in the east, leading to a space that is 3.6 meters wide and 21 meters long. This part is severely destroyed, yet according to the evidence it must have consisted of three rooms and led to the space of the eastern and western millhouses through two entrances on the north side and led to the southern parts from another entrance in the southern side (Fig. 3, section A3).

The space of the eastern windmill consists of a large room known as the millhouse (As Khaneh), a northern room and two side corridors in three floors. Today, the main room (11 x 7 m) and the western corridor have been buried due to the collapse of the roof. One can enter the side corridors through a door on the sides of the northern room of the millhouse. The eastern corridor is 110 cm in width and its length equals that of the millhouse (around 14 m) in three floors, and it is covered with a barrel vault. Currently, the first floor of the corridor is not accessible due to falling debris. The middle floor is 230 cm high and the third floor of the corridor is 150 cm in height. The construction of vaulted corridors next to the main walls of the windmill, while creating an installation and storage space, has played a role in strength and stability of the main walls (Fig. 3, Section A1).

The architecture of the western Asbad is more intact compared to other parts; the millhouse is 11 x 7 meters that the millstone was located in the middle of its northern part in the form of a space with thick side walls, and two roofed spaces had been constructed with barrel vaults on both sides. It is impossible to access this part of the Asbad as the entrance has been blocked. However, according to the visible evidence and also the structure of other windmills in Sistan, the western chamber was intended to be used for putting flour and the eastern chamber was a place to pass from the facilities of the millstone and to enter the northern space and from there to the eastern and western corridors. The northern room, a space measuring

180 x 300 cm, has two doors on the sides for entering the corridors (Fig. 3, Section A2). The eastern corridor is 130 cm wide, while the western corridor is 80 cm in width. What is noteworthy is that the width of the western corridor of the western Asbad and the eastern corridor in the western Asbad connected to the side walls of the Asbad (the side main walls) is greater and the width of the corridor connected to the central wall (the main or joint wall) is less that this difference has been made based on precise calculations to ensure the stability of the main walls. There is a window, measuring 60 X 70 cm, in the north of the third floor of the eastern corridor.

The southern courtyard of SePareh Asbad (Fig. 3 section A4) is a 25 x 20.5 m space, the entrance of which is from the northeast and next to the windmill entrance. Three sides, i.e. the northern, western and southern of the courtyard are formed in accordance with the structural direction of the windmill (in the north-west-south-east direction), but its eastern side with a slight deviation is in the north-south direction. Accordingly, the eastern rooms of this courtyard that today just some parts of their walls remain were built in the north-south direction. The width of these rooms is about 4 meters, which due to the high degree of destruction, commenting on the number and length of the rooms is impossible (Fig. 3, Section A5). This issue also applies to the all-around southern rooms, the width of which is about 3 m. The main walls of the windmill have a thickness between 70 and 80 cm (Fig. 3, Section A6).



▲ **Fig. 3: Plan and View of SePareh Asbad (Authors, 2021).**

The building of SePareh Asbad has had ornamentations on the exterior of the eastern and western mail walls and today some parts of the decorations

remained on the western and central main walls. The decorations of the eastern wall are in the form of a honeycomb than include rectangular, cruciform and large diamond shapes consisting of nine small rectangles. The ornamentation of the central wall is different and is in the form of four rows of small ledges, the upper part of each of which has taken a half-cruciform shape (Fig. 4). Honeycomb decorations are found in some buildings of the Zahedan Kohneh's Rabaz, the side walls of the southern windmill of Hozdar, Qala Rostam Asbad, Arg-e Varmal, and numerous buildings in Girdi complex. This type of ornamentation is one of the common decorations in the buildings of the Islamic era of Sistan.

Place 2: The western windmill is located 85 meters west of SePareh Asbad. This building is categorized among single-opening windmills, with the width of 7 meters. However, taking the bell's bund on both sides into account, its opening is 13 meters wide. The windmill entrance is situated southernmost part of the eastern side. The entrance leads to a 7.5 X 2.5 m corridor, of which currently some trances of its walls can be recognized. This hallway has an access to the northern room through a door that is 70 cm wide and from there it leads to a corridor with a width of 70 cm and length of 5.6 meters. Just like SePareh Asbad, this windmill has a large courtyard that today parts of its side walls remain. In total, the Asbad building along with the courtyard occupies a space which is 26 x 27 meters (Fig.s 5 and 6).

Fig. 5: Windmill 2, Rendeh complex, from the east (Authors, 2021). ▶

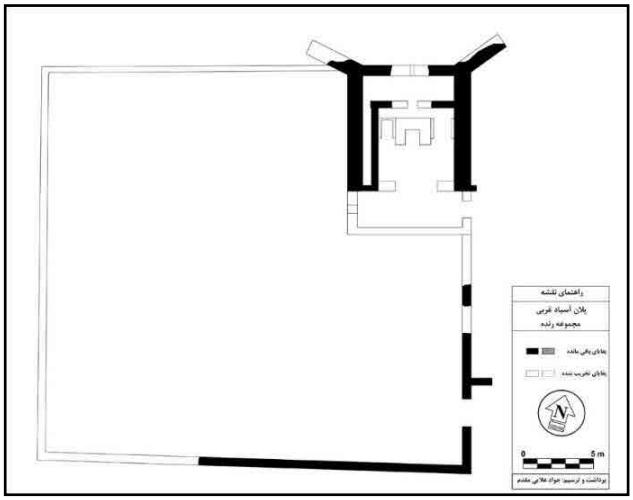


Fig. 6: The plan of Asbad 2 (Authors, 2021). ▶

Place 3: the southern windmill is located 520 meters south-east of SePareh Asbad and situated in the enclosed space of Zabol television transmitter station. The mentioned Asbad is a simple windmill consisting of a central room, side corridors and a southern room, along with a courtyard in its south. The Asbad entrance, just like other windmills of the region, is located on the southernmost part of the eastern side, from which one can enter into the entrance room and then to the mill house. The mill house is 8 X 5 m space connected to the northern corridor measuring 140 cm wide and 8 meters long through an entrance that is 80 cm wide. This corridor leads to the side corridors from the westernmost and easternmost parts. The opening of the windmill is more than 10 meters wide that unfortunately its bell's bunds have currently collapsed. The windmill and the courtyard cover a 23 x 17 m space that unfortunately, nothing remains of the courtyard wall today but some slight trace (Fig. 7).

◀ **Fig. 7: The southern Asbad-from the north-west (Authors, 2021).**

Place 4: 63 meters northwest of SePareh Asbad, in a space of 28 x 20 meters, remains of several parallel stacks are seen in the northwest-southeast direction, which are nine and three meters apart, respectively. Although no certain comment can be made regarding the nature of this place without archaeological excavations, according to the evidence of the thick longitudinal walls with a distance compatible with the opening and body of windmills, it is not unlikely that these remains may have belonged to a windmill in this place. It is should be mentioned that one of the local elderly people, quoting his father, referred to this place as a broken Asbad.

Place 5: Haji Abad windmill is located 1700 m north of SePareh Asbad and is one of the large windmills with ancillary facilities. This 25 x 27meter mill consists of two parts, the windmill and the western and southern facilities. The opening of the Asbad is 8.8 meters wide. The side walls of this windmill are 7 m long and its thickness ranges between 110

and 130 cm. Today, only part of the wind-directing wall in the north of the western wall remains. The millhouse space is not visible due to the collapse of the roof and walls, and only remains of two walls parallel with the main walls, constituting the longitudinal side corridors, are observable. The western corridor is 75 cm and the eastern corridor is 90 cm wide. Ancillary facilities include a courtyard in the southwest and a set of rooms around it covering an area of 450 m2 (Fig.s 8 and 9). It is noteworthy that due to the multiplicity of side rooms, this windmill is also known as "As-e Chehelkhaneh" (meaning a windmill with forty rooms).

Fig. 8: Haji Abad Asbad- from the north (Authors, 2021). ▶

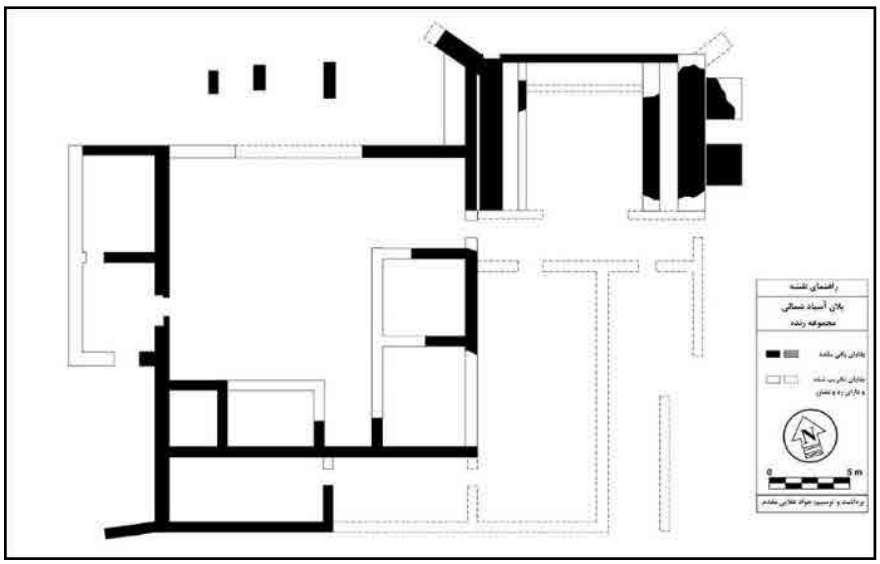


Fig. 9: Plan of Haji Abad Asbad (Authors, 2021). ▶

Place 6: 330 meters southeast of Haji Abad Asbad, there are the remains of an adobe building that due to the high volume of debris, its plan is mostly unclear. A wall with a length of 6 meters and thickness of 75 cm and traces of another wall parallel to this one are seen at a distance of 5 meters, resembling the side walls of a windmill. In the south and west of these wall, remains of rooms and architectural side spaces could be seen, a structure which is comparable to other windmills of Rendeh region (Fig. 10). It should be mentioned that this place is also famous as As-e Khorkak, meaning a small mill.

◄ Fig. 10: Khorkak Asbad- from the north (Authors, 2021).

Place 7: 360 meters north of Haji Abad Asbad, there is an oval-shaped mound measuring 36 x 40 meters with the height of 4 meters, on surface of which there are the remains of two parallel walls, being 8 meters apart. The thickness of the walls is about 1 mere. Currently, 4.5 meters of the Eastern wall and 3.5 meters of the western wall remain. This mound is known as Tapeh As and Tapeh Asak among the elderly people of the nearby village.

B- A castle known as "Arg-e MirJamal" represented by number 8 in Fig. 1 is regarded as the largest architectural remains of Rendeh region that unfortunately has undergone severe destruction and change due to the development of a new village inside it. This place has been a huge castle measuring 320 x 320 m in the northwest direction, in which evidence of several periods of construction and settlement can be found, as indicated by field surveys and satellite imagery (Fig. 11). The first period is synchronous with SePareh Asbad and other ruined buildings of the region and is related to a time during which the main citadel was constructed and, as the residence center of a ruler or an emir descendant, it was supervised by the great ruler of Sistan. The second period dates back to the late-Islamic centuries, particularly the Qajar period. Parts of the citadel, which was destroyed just like other towns and regions associated with the city of Sistan (the Zahedan Kohneh) during Timurid and then the Uzbek invasions, were reconstructed in this period. Zolfaghar Kermani wrote during the Qajar period, "the citadel that is under restoration is still unfinished and in the center of the citadel a high watchtower has been erected where several guards are stationed day and night to monitor the surroundings...." (Kermani, 1995: 165) Today, to the northwest of the castle, the remnants of the fence of an oval space measuring 50 by 40 meters can be seen, presumably from the construction work described by Zolfagar Kermani. The third settlement period at this site is associated with the new development by the people of Lower Rendeh village, as a result of which most of the ancient architectural remains were removed.

C- Talar mansion, indicated with No. 1 in Fig. 9, is one of the significant buildings southwest of Rendeh complex. According to the satellite images, the mentioned building has a 30 x 30 meters square plan. Unfortunately,

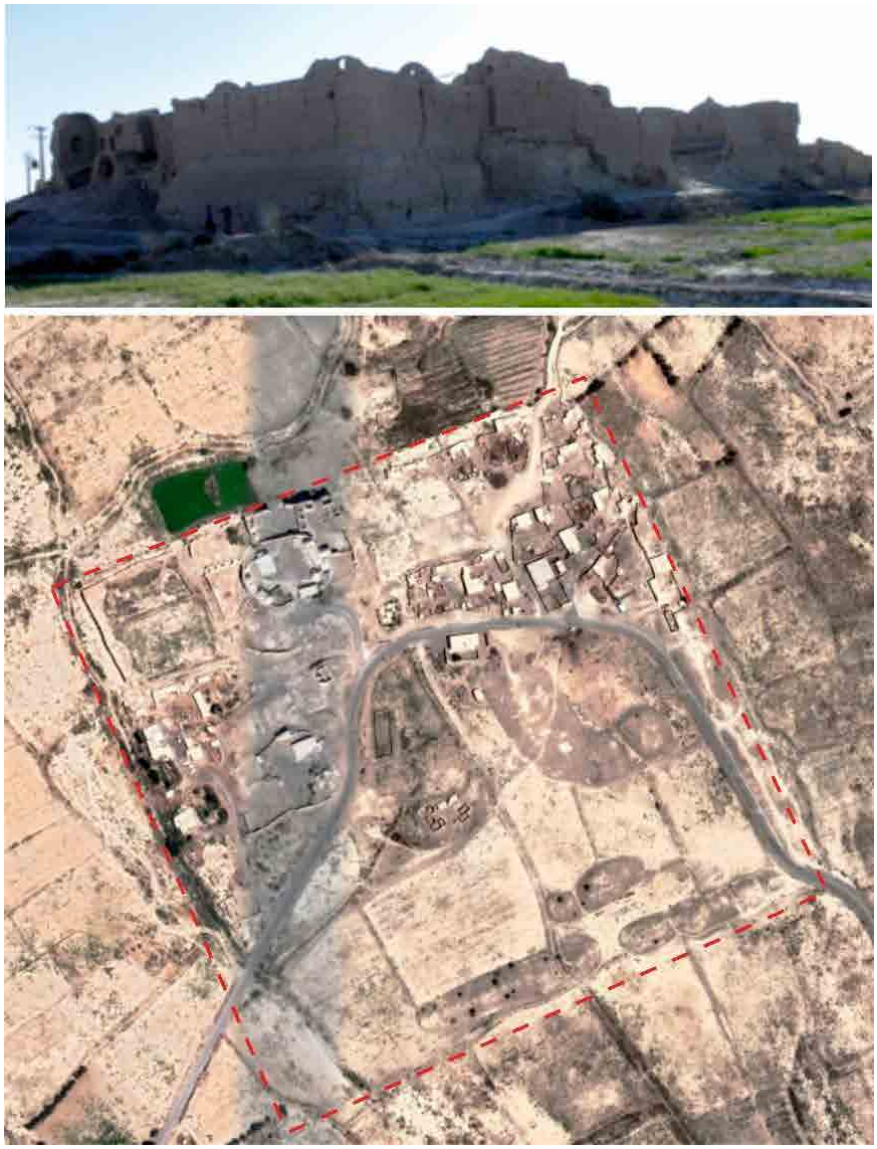


Fig. 11: Top: the northern front of Arg-e Mirjamal (Authors, 2021); bottom: satellite image of Arg-e Mir Jamal (Google Earth). ▶

parts of the building have collapsed in the eastern and central sections, leaving only some remains of a large hall measuring 30 x 8 meters to the west. What is interesting is the richness of decorations in the western hall, so that the interior of its walls has been decorated in two floors with false arcs and niches which are 70-120 cm high and 50-70 cm wide (Fig. 12). The main walls of the hall are 1.8 meters thick and today about 6 meters of its height remains. The satellite images indicate that the above-mentioned building has been situated inside a 58 × 58 meter square fence.

D- Small building remains: At Rendeh complex, the remains of nine small buildings can be observed, varying in size from 250 m2 to 600 m2. Unfortunately, in the current state and in the absence of excavations, the plan of none of these buildings is completely clear, and only some of

◀ Fig. 12: an example of decorative niches in Talar mansion (Authors, 2021).

the large and small rooms are visible in them. The rooms include spaces measuring 3.5 x 3.5 meters, 4.5 x 3.5 meters, 6 x 4 m, 4 x 4.5 m, 4 x 5 meters, 3.5 x 7meters and 1 x 3meters. All of these buildings are made of raw clay and mud mortar (Fig. 13).

◀ Fig. 13: examples of small building remains at Rendeh complex (Authors 2021).

E. mounds and stacks: At Rendeh complex, from Abil village to the northernmost point of the complex (Tappeh As), there are 24 small and big stacks and mounds connected to each other with varying heights between 1 and 3 meters, sizes of which vary between 300 and 4000 square meters. These mounds are the remains of small and large buildings, on some of which traces of walls can be recognized. However, some of these mounds are related to small kilns, on the surface of which forge welding and heated bricks can be observed.

Chronology of Rendeh Complex

During the investigation of Rendeh complex, samples of surface pottery

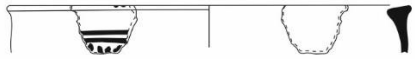
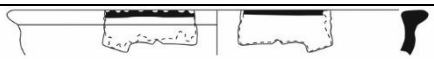
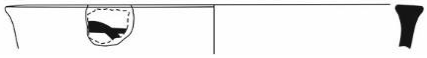
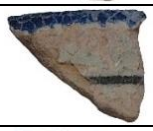
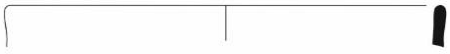
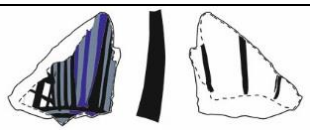
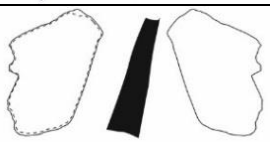
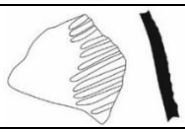
fragments were examined in situ so as not to disturb the natural distribution of surface cultural materials. This was done in such a way that their specifications were first recorded, then photographs were taken and finally the representative samples were sketched on the same place and then they were returned to their original place. Next, the representative samples were compared with pottery examples of dated sites based on their technical specifications and decorations to achieve a relative chronology of the site. A total of 147 pottery fragments were recorded in Rendeh area. An example of each type was selected for typological comparison, the results of which are presented in table 1, based on which the pottery samples can be attributed to the 6th and 9th centuries AH. This period can be called as one of the peak eras of Sistan, during which the city of Sistan (the Zahedan Kohneh) functioned as the ruling center. Similar to the main city of Sistan, i.e. the Zahedan Kohneh, the early abandonment of this city may have taken place due to the Timurid invasion (Mousavi Haji, 2009: 77). However, given the role of Asbads in livelihood of its population, it is most likely that some of these buildings continued to operate on a limited basis during the following period.

Architectural Study of Rendeh Asbads

In terms of plan organization, the windmills of Rendeh region are divided into two groups of single and twin windmills. Accordingly, SePareh Asbad is categorized as twin windmill and the rest of them are classified among the single type. Both windmill types of Rendeh complex consist of a two-story building. The lower floor or "As Khaneh" (Persian equivalent for millhouse) includes the main chamber of the millstone, side corridors and the southern rooms. The second floor or "Par Khaneh", characterized by side main walls and the "wind directing" wall, is where the windmill propeller is placed. An interesting aspect of these windmills, which is among the features of Sistan Asbads, is the existence of a wind inlet in the form of an open corridor and it is for this reason that they are known as corridor windmills. The advantage of this corridor is more effective direction of wind and increased power of the windmill. Although this part has been collapsed in Rende Asbads, leaving only a little trace of it, its examples can be found in the windmills of Hozdar, Sistan (Fig. 14).

In terms of the placement of the main rotation axis, the Rendeh Asbads are categorized among the vertical axis windmills. In this type of Asbads, the wind vanes are directly mounted on the wooden vertical axis, which is directly connected to the millhouse and the millstone.

Table 1: Pottery samples of Rendeh complex, Sistan (Authors, 2021). ▼

Row	Photograph	Sketch	Source of the sample compared	Date
1			Kashan (Available at Otago Museum) Lane, 1971: no.6.A	8th century AH
2			A sample from Syria Watson, 2004: 295, cat.K.6	7th century AH
3			A sample from Syria Watson, 2004: 401, cat.R.6	8th century AH
4			Syria and Egypt Watson, 2004: 402-404, cats.R.7, R.8, R.9	8th and 9th centuries AH
5			A sample from Iran in Naser Khalili's collection Grube, 1994: 182,183, nos.184,185 A sample from Afghanistan in Tariq Rajab Museum Fehervari, 2000: 150, no.184	6th century AH 6th and 7th centuries AH
6			A sample from Iran in the Ashmolean Museum Allan, 1995: 87, fig.2 A sample fron Raqqa in the Hitchcock collection Hitchcock, 1948: nos.33, 34	6th and 7th centuries AH
7			A sample from Iran in Abgineh Museum (Ghayeni, 2000: no 22/27)	
8			A sample from Kashan Watson,2004: 388, cat. Q. 18	8th century AH
9			A sample from Gorgan in Abgineh Museum (Ghayeni, 2000: no 30/19)	6th century AH
10			A sample from Iran in Naser Khalili's collection Grube, 1994: 136, no, 135	5th century AH
11			A sample from Rey Willkinson, 1963: no.37	6th and 7th centuries AH

The building components of the Rendeh Asbads can be considered in two parts: the main building and the ancillary facilities. The main building of these windmills consists of two main walls, bell's bunds, central bell's bunds, the millhouse room, the northern chamber with a lower wind catcher window (Darbad), longitudinal side corridors and the temporary southern warehouses. In SePareh Asbad, however, there is also a middle main wall, separating the two openings of the windmill. Due to the collapse of the debris, the interior of the millhouse is blocked in Rendeh complex, although parts of it can be seen in SePareh Asbad and the northern windmill. On the basis of the existing evidence, such windmills have two vaulted space on either side of the millstone platform, an example of which is found in Hozdar Asbads (Fig. 15).

Fig. 15: The interior of a Sistani style Asbad in Hozdar region (Authors, 2021). ▶

A noteworthy point in the windmills of Rendeh region, is the existence of a private courtyard and rooms surrounding it (Fig.s 3, 6, and 9), which are not found in other windmills of Sistan region, neither the examples from

the earlier period and nore the examples from the later periods. According to the remains available, most of the rooms around the courtyard are longitudinal. This kind of longitudinal rooms in Sistan mostly functioned as storerooms.

Study and comparison of flour production places in Sistan

The existing views differ on the number of Asbads in Sistan, with most of them indicating that there are fewer than 10 windmills. In his latest study of Persian windmills, Mishmast claims that the number of such mills in Iran and Afghanistan is now around 300, of which 12 cases are located in Sistan (Mishmastnehi 2021: 4-6). An archaeological survey of the extensive plains of Sistan, conducted in 2007-2008, identified about 1700 ancient sites, among which about eight Asbads have been directly discovered. In addition, as part of this study, several large collections of architectural mounds and sites were recorded, including the remains of a number of Asbads (Mousavi Haji and Mehrafarin, 2008 and 2009). The summary of the archaeological survey in Sistan regarding the Islamic eras reveals evidence of settlement in Sistan from the end of the 4th century AH to the present time. However, the largest and greatest number of its settlements date back to the mid-Islamic period (from the fourth to the ninth centuries AH). Although the scattering of the mid-Islamic sites is clearly visible in most regions of Sistan on the Iranian side, the main concentrations of settlement scattering can be seen in four major regions, including the central part (part 1) and northern part (part 2) of the northern plain and the south-eastern part (part 3) and central part (part 4) of the southern plain. An investigation of the existing archaeological reports has shown that there are traces and remains of windmills in all these areas3, but there is only one unit of windmill in each of the parts 1, 3 and 4. As discussed above, only in part 2, encompassing Jalal Abad and Rendeh regions, the remains of at least five Asbads and two ruins known as Asbads are currently found. Moreover, the largest known windmill in Sistan is also located in this region.

During the mid-Islamic centuries, Sistan plain was so prosperous and considered among the richest provinces of Iran that Timur Gourkani, when visiting this region, stated that there are three harvests a year in this region (Brion, 1993: 92). The author of “History of Sistan” (: 58), a book on the mid-Islamic centuries, has called Sistan the best land in terms of prosperity and fertility. The large extent of farmland and the existence of fertile soils have been the mains reasons for mass production of agriculture

in the Sistan region, in such a way that Sir Percy Sykes (1957: 393) also points to Sistan as the grain reservoir of Asia and the Little Egypt. These agricultural products required numerous facilities to produce flour, so based on a simple calculation and with respect to the number of windmill openings Rendeh region in the mid-Islamic centuries had three times as many facilities and equipment as other regions of Sistan. Therefore, it can be concluded that Rendeh area was and operated as the most important center for flour production center in Sistan during the mid-Islamic era.

Conclusion

Considered one of the most important provinces of Iran at various times in history, and due to its favorable climatic conditions, Sistan enjoyed great prosperity until a few centuries ago. Despite the series of wars taken place among different governments during the Islamic era, this territory maintained its glory until the time of the Timurid dynasty. Afterwards, even though during the Safavid era signs of returning to the greatness of this region can be seen again, the rise of the Qajar dynasty to power and the division of the Great Sistan into two Iranian and Afghan parts, caused this region to experience a kind of turmoil and it could never regain its former glory.

Despite the fact that the development period of Sistan was influenced by various natural, political, communication and commercial factors, it can be argued that throughout history the most important reason for its development was the favorable natural condition, particularly fertile land and abundant water. This factor, combined with the use of various technologies in irrigation (building dams, canals and windmills), livelihood and agriculture (mass production of flour by Asbads), allowed Sistan to reach such a level of prosperity and wealth to be known as the “grain reservoir” and “bread basket”. Meanwhile, Asbads have had a special position since this unique structure, of which the oldest examples exist in Sistan, played a significant role in the production of flour needed by the people.

According to the present research, it was revealed that there are traces and remains of seven Asbads, a mansion, remains of nine small buildings and twenty four low mounds and hills in Rendeh region. Referring to the relative chronology conducted based on the typological comparison of surface pottery samples of the site, this complex belongs to the mid-Islamic centuries and its ceramic samples suggest that these buildings were active in the 6th to 9th centuries AH. This time coincides with a period in Sistan,

when the Zahedan Kohneh (the city of Sistan) with a 325-hectare enclosed Sharistan, served as Darul-Hukomah (the seat of government). It can be argued that this complex was one of the centers and towns in the suburbs of Sistan, surpassing other contemporaneous areas in Sistan plain in quantity and grandeur. It has been the most important and largest flour production center of Sistan in the mid-Islamic centuries. This region was so important that a huge ten-hectare castle, as well as magnificent buildings such as Se Tallar (a building with three large halls) were constructed in it.

The interesting point about the Asbads of Rendeh region lies in their architecture. First of all, it should be mentioned that although the oldest known Asbad in Sistan is the Asbad of the Zahedan Kohneh, the oldest twin Asbad (with two openings) is the famous SePareh Asbad. Therefore, it can be argued that the manifestation for the birth of twin Asbads began in Rendeh area and similar examples were built in Hozdar area as well as the city of Nehbandan (Neh Bastan) in later times. With an over 10-meter width at each opening, this windmill is the largest known Asbad in Iran. On the other hand, SePareh Asbad and three other windmills of Rendeh, unlike other windmills of Sistan (both belonging to former and later periods) have a private courtyard and storerooms around it (apart from the warehouse in the south of the main body of each windmill). This adds to the importance of these Asbads, since the existence of an independent large yard along with storerooms is another indication of wider activities and a more organized storage system.

Endnote

1. A part of the archaeological research was conducted using the UOZ-GR-3362 grant from the University of Zabol.

2. 1It should be noted that in addition to the mentioned cases, a number of articles about Asbads by numerous authors have been published in different conferences, where no mention has been made to Rendeh Asbads. And moreover, many of them have been unfortunately presented with very minor alterations (sometimes just a few words), which is far from the standards of scientific ethics. Therefore, the author refrains from mentioning them.

3. It is noteworthy that the remains of five Asbads are also found in Hozdar area (west of the southern plain of Sistan). These windmills do not coincide with the windmills of Rendeh region and date back to the late Islamic eras. Therefore they have not been mentioned here.

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پژوهش‌های باستان‌شناسی ایران
فصلنامهٔ علمی پژوهش‌های باستان‌شناسی ایران
P. ISSN: 2345-5225 & E. ISSN: 2345-5500
https://nbsh.basu.ac.ir نشانی پایگاه نشریه:
شمارهٔ ۳۷، دورهٔ سیزدهم، تابستان ۱۴۰۲
دانشگاه بوعلی سینا
انجمن علمی باستان‌شناسی ایران

بررسی مجموعهٔ آسیادهای رندهٔ سیستان
(بقایای معماری بزرگ‌ترین تأسیسات بادی تولید آرد شرق ایران در قرون میانهٔ اسلامی)

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شناسهٔ دیجیتال (DOI): https://dx.doi.org/10.22084/NB.2023.26798.2519
تاریخ دریافت: ۱۴۰۱/۰۶/۱۱، تاریخ پذیرش: ۱۴۰۱/۱۲/۲۸
نوع مقاله: پژوهشی
صص: ۲۷۱-۲۴۷

چکیده
بشر در طول زندگی خود همواره در تعامل با محیط بوده و رشد و گسترش تمدن بشری در بستر محیط طبیعی و توانایی بهره‌برداری با آن به‌وقوع پیوسته است. در این‌میان تکنولوژی استفاده از پدیده‌های طبیعی در مناطق مختلف، ازجمله مظاهر هم‌سویی انسان با محیط پیرامونی است. یکی از این تکنولوژی‌ها، ساخت و بهره‌برداری از آسیاد است که تا به امروز قدیمی‌ترین نمونهٔ آن مربوط به تمدن ایرانی می‌شود. سیستان را محل ابداع آسیاد می‌دانند و امروزه بقایای زیادی از آسیادهای تاریخی در آن وجود دارد؛ هرچند شناخته‌شده‌ترین آسیادهای سیستان مربوط به مجموعهٔ صفوی حوضدار است، اما در منطقهٔ رنده واقع شمال‌شرقی سیستان مجموعه‌ای دیگر از آسیادها وجود دارد که برخی از آن‌ها در جایگاه منحصربه‌فردترین این نوع سازه‌های کشور قرار دارد. با وجود اهمیت این منطقه، تاکنون تحقیقی جامع درمورد آن، به‌ویژه درمورد قدمت، ساختارهای معماری و مقایسهٔ سبک‌شناسی آن صورت نگرفته است؛ از این‌رو در این پژوهش نگارندگان با تکیه‌بر مطالعات میدانی و بررسی، اقدام به برداشت پلان، مطالعهٔ معماری و گردآوری اطلاعات موردنیاز نموده و ازسوی دیگر با مطالعات تطبیقی، در جهت نیل به هدف اصلی پژوهش، یعنی درنهایت با تجزیه و تحلیل اطلاعات اولیه، به مطالعهٔ جامع ساختار معماری آسیادها و آثار دیگر مجموعه رنده می‌پردازد. براساس این پژوهش برای اولین‌بار پلان این سازهٔ منحصربه‌فرد با بررسی دقیق شواهد معماری، ترسیم و بازخوانی شد. نتایج حاکی از آن است که قدمت آسیادها و مجموعه محوطه‌های منطقهٔ رنده، بیشتر از آسیادهای منطقهٔ حوضدار بوده و مربوط به قرون ۶ تا ۹هـ.ق. می‌گردد. این مجموعه دربردارندهٔ بیشترین تعداد آسیاد مربوط به قرون میانهٔ اسلامی است که براساس همین می‌توان آن را بزرگ‌ترین مجموعهٔ تولید آرد منطقه معرفی نمود. در این‌میان، آسیاد معروف به «سه‌پره» بزرگ‌ترین آسیاد شناخته‌شده شرق ایران است که در دوره‌های بعد، نوع و سبک معماری آن با حذف حیاط جانبی و اتاق انبارهای پیرامون آن، در آسیادهای صفوی منطقهٔ حوضدار، تداوم یافته است.

کلیدواژگان: سیستان، رنده، آسیاد، بررسی باستان‌شناختی، مطالعهٔ معماری.

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ارجاع به مقاله: علایی‌مقدم، جواد؛ و موسوی‌حاجی، سید رسول، (۱۴۰۲). «بررسی مجموعهٔ آسیادهای رندهٔ سیستان (بقایای معماری بزرگ‌ترین تأسیسات بادی تولید آرد شرق ایران در قرون میانهٔ اسلامی)». پژوهش‌های باستان‌شناسی ایران، ۱۳(۳۷): ۲۷۱-۲۴۷. https://dx.doi.org/10.22084/NB.2023.26798.2519
صفحهٔ اصلی مقاله در سامانهٔ نشریه:
https://nbsh.basu.ac.ir/article_5322.html?lang=fa

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