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Example of sustainable architecture in forgotten Iranian architecture (abads in Sistan and watermills-bridges in dezful), case of Iran

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ABSTRACT

Ignoring sustainable basis of Iran's traditional architecture and different factors which affect it caused many parts of the forgotten structures to be destroyed. Although all the phylosephical and religious elements which are water, air, light, and soil have been used in the best way in the traditional architecture of Iran's city, aerodynamics and hydrolics from wind and water were the most employed useful energies, which were very efficiently used in the windmills and watermills, in Iran' traditional architecture. The type of materials, structural techniques, and elements, which were used to keep these structures firm, were of high quality to sustain in the environment and they could adapt the man-made structures to the beautiful environment, in comparison with the existing materials. In addition, they could preserve the environment goodness. Windmills, which were built to benefit from 120-day winds of Sistan Province, are of the best examples of using natural powers. Some of the Iran's windmills are as old as 2800 years. Also, some historians consider the watermills to be around 1700 years old. The watermills can only be found in a limited number of areas, as their rotation require powerful and continuous flow of a river like Dez River. The method of the current research is of descriptive-analytical type. Data gathering was done in libraryand fieldwork methods. Following the study of the history of different windmills and Dezfoul watermills, we investigated the quotations from tourists, the books which have been remained from that time, and the belief of indigenous people to find the place, application, and the architecture of these wind and water mills. At the end, we concluded that the recognition of such examples of architecture can be a guide to build a comfortable environment, which is in harmony with the existing global organization. Thus, the values of traditional architecture and the traditions of environmental values of Iran's architecture have the potentiality to make an efficient use of energy and to reap reward from the ecological powers, specifically sustainable and harmless energy. For this reason, some examples of windmills and watermills were studied and their architectures were invesitigated. To preserve such precious historic remnants can be a center for attracting tourism and can bethe signs of cultural, articstics, and historical progress of a nation, which express its creativity and adaptability to nature in an excellent way.

Introduction

The theory of sustainable development and sustainable architecture is among the most controversial topics in the architecture of the current era. In fact, being sustainable is a comprehensive conceptand does not lead to an architectural style, like what other trends did. Although the main concern of having sustainable architecture is to protect the environment, dealing with this architecture needs considering all of the oldarchitecture trends, which concerned about making the least use of energy and materials. It can be said that sustainable design is a type of architecture in which maximum environmental potentials can be exploited to the users benefits and for which many innitiative tools and approaches are used. At the same time, sustainable architecture can decrease the bad conditions, resulted from building and constructing new structures. The building, from the early stages of being constructed, should react well to the enviroment and should have a minimized adverse effect on the environment. With respect to the sustainable design, the old architecture of Iran is a good choice to be investigated both from theaspect of type of attitude toward human beign and the environment as well as its applied approaches. The bases of Iran's architecture are taken from nature and its powers ((light, water, wind, and soil) and are strongly indespensible from the environment [1].

The word "asyab" is composed of two parts, *as* and *ab*. "*As*" means grinding the grain under millstones[2]. In Amid Dictionary, "*as*" is defined as two pieces of rounded and smooth stones, of which the bedstone with a mandrel in it is located under the runner stone. The runner stone rotates with the power of man's hand, water, electricity, water, or steam and mills the grains.

A long time ago, Persian people took a step to exploit the power of nature, by building watermills and milling the grains. Before building watermills, man had to place reliance on his own hands or cattle power to mill the wheat. Thus, the first source of power to mill was the power of hand. After that, man started to use his livestock to do the act of milling. In some parts of Iran, the term Kharas was coined, which was composed of

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two parts. The first part, khar, means donkey, and the second part, as, means milling. This term was used to show the usage of donkey, camel, cow, or horse to rotate the millstone [3]. Until recently, these kinds of mills were used to extract oil from the seeds [the term extractor or extractor horse is related to this action]. In Yazd City, these kinds of mills were operated with camel to rub henna, and were called Mazari.

The first time that wind and water power was recognizedas a source of energy is not clear. According to the domestic and foreign documents, Persian people were the first to use wind and water power to run windmills and the mill wheels [22]. It is generally admitted that after succeeding in profiting from the technology of using one-directional movement of water to rotate the millstone, Iranian started to use wind power to rotate the millstones and draw well water from underground. There is no doubt that the first mills were built in a region in Sistan or Sagastan] Province to Ghuhestan [or Kuhestan], thousands years ago [23].

Windmills and watermills cannot be found in all parts of Iran, as their rotation require powerful and continuous natural powers. The Southeast of Iran has all these necessary conditions and it is many years that its geographical merits are being exploited. With the advent of mechanical mills, which are called fire mills by indigenous people, the watermills and windmills were forgotten and their number was decreased. Currently, in some of Southwest and Southeast towns of Iran, the windmills and watermills are used. However, from among many windmills next to each other, only one or two of them are used and the rest only play the role of a reminder of the town prosperity erain the way that we are disheartened by their destruction. In the present article, the technology of windmills power in sustainable of desert areas and technology of watermills power in sustainable design of hot and humid areas of Iran are studied. To this end, the origin of the mills wasinvesitigated. Then, their application, architecture, method of construction, elements, and the way they work were explored. Next, Lutak, Neshtifan, and Nehbandan windmills as well as Dezful watermills, in a field-work study, were compared and analysed and the conclusion are presented.

Asbads or Windmills

There is no evidence on the exact point in time of the invention of the windmills. Most of the tourists and historians, who throughout the centuries traveled to Pars lands, considered the root of this invention to be in the years before the invasion of Muslim to Iran [24]. However, it is reasoned that the origin of the windmills should date back to one thousand years before the creation of ship sailcloth, as the function of both, windmill and sailcloth, is the same. That is, both create a type of movement by wind power [25]. Some historians consider the emergence of the windmills to be in 200 BC [4].

According to Piccoloskian, most of the Iran's towns or cities had mills in Parthian and Sasanid dynasties. They had strict rules for using these mills, payment of the millers, and the goods[5]. Jan Naar, in his book, points to a kind of windmill that was used in China to draw well water and is still used in some cities. This type of windmill, though has vertical axis, is completely different from those of Persian lands in structure. This is because the sails are situated in an open area and a wind-directing system is not mounted on the sails [6]. Ali BaladKabashi in Great Encyclopedia of Islam book has cited from Ghazvini and habibi's book [7] of The history of Afghanistan after Islam that Khorasan Province to be on par with Sistan in using and constructing mills [8]. But the point is that, in most of quotations from historians, windmills are recounted as the unique feature of Sistan Province. This fact simply indicates that there were other mills in other lands, but they were not considered as the typical characteristic of that land.

In Sistan land and Khaf planes, located in Zouzan plane, a type of wind, called 120-day wind blows. This fact made the people of the area invent a tool to put the wind to good use. The advantage of this wind is that it blows very regularly and with steady speed. It blows from northwest, west, and southwest, about 4 months a year, May, June, July, August [9].

According to the historical documents related to Sistan, indigenous people gained advantage of wind power in different aspects of their life, including grinding the wheat [according to Masoudi]and drawing well water according to Tit[10]. The mills were also used to ventilate house air. That is, they had a function similar to that of the wind catchers in the central cities of Iran. However, it is not clear whether the wind catchers are as old as windmills or not.

Sustainable architecture of the asbads

Windmills are made of two stories. On the top or house of as[the tool that mills the grains], lateral curved walls direct the wind to the sails, which are fixed on the windmill. There are more than 1000 windmills in Khorasan and Sistan Provinces which are on the way to be completely destroyed.

The body and walls of this structure are, like a tower, situated in the middle of the building. They move three sails of eight sails of the polygonal structure of the windmill. The rest of the sails, which are not in the wind direction, do not inhibit the circular movement of the sails. The sails are mounted on a vertical mast. In the sails, the mast rotates in the hole of a horizontal lumber and the end of the mast, which is inside the mill, moves the runner stone on the bed stone. The above room, depending on the direction of the wind, has two walls toward north and south. The entrance of the room is located on the north side of the top room and occupies a half of the north side. The entrance is located at the place that the wind blows to the sails. The exit is located in the south, in which the distance between east and west is completely open. The above room has no roof and the opening is funnel-form. Thus, two sides of the opening of the wall are diagonally located toward the wind direction and, as a result, the wind strikes the sails powerfully. Ground floor of the system is a place where the wheat, flour, and other tools are collected. One of the prominent characteristics of windmills is that the sails, though being light and built by rustic building materials, are covered by canes to avertthe structure destruction by the termites (Fig.1).

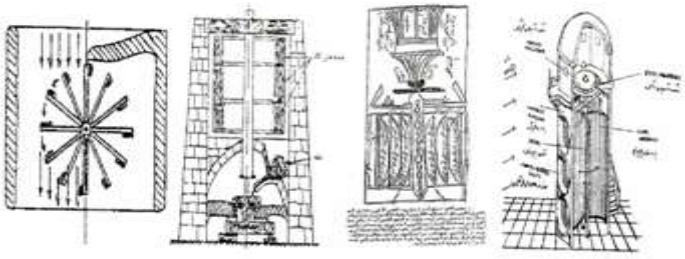

Figure 1.The two right figures are the primary models of windmills. In accordance to Dameshghi (1925) description, the windmills sails were at the bottom and the millstone was located above [11]. The two left figures are the modern modles of the windmills in which millhouse is located under the windmills sails [26]

Examples of asbads

Lutak windmills

The Lutak windmills were found 62 kilometers far from the southeast of Zabolcity, in other words, 5 kilometers to the north of archeology base ofShahr-e-Sukhte[The BurntCity].The emergence of this type of windmill dates back to Sasanid period[12].

According to windmills plan, this structure was made of two floors. The ground floor had three rooms, one of which was milling house. Milling house consists of water container and a place to put the millstone as well as two other rooms, which are store or service rooms. On the first floor, only wind wheel existed. The building materials of this structure were brick and thatch. The thick walls of the structure signal the structure old history(Fig.2).

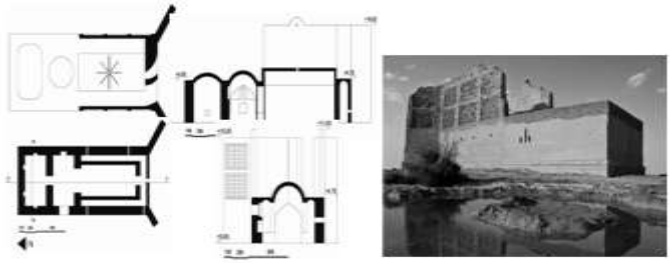

Fig. 2. **The plans of watermill's ground and first floors; The profile of the windmills [Note that the thick walls sign the oldness of the structure]. [21]**

Neshtifan windmills

Neshtifan with 10 degrees and 60 minutes longitude as well as 24 degrees and 26 minutes latitude is located 20 kilometers far from Khaftown, in the margin of flat grounds ended in desert. It is in a gentle slope of one of the alluvia of Kalshour River. It is ended to Bakhzar Mountain in north, Abasabad, Mohammadabad, andBehdadiantowns in south, Barabad and Sungan towns in east, and Kalateha lands in west. Neshtifan had 40 windmills, most of which are ruined now(Fig.3). The building stuff of these windmills is addob which is filled in with thatch[13].

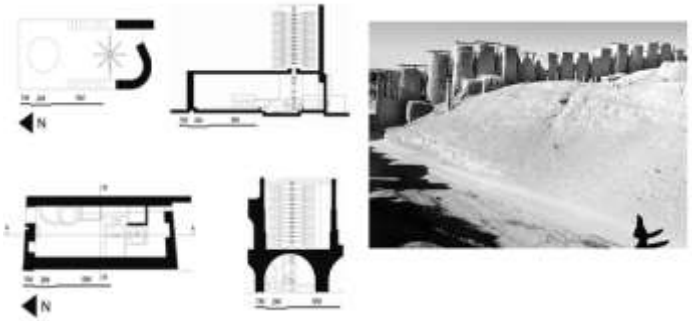

Fig. 3.**Neshtifanwindmills are built in a multi-storied form to better gain the wind power. Longitudinal and latitudinal profiles of the windmills; the wheel and giant sails, which are inside the windmill; the plan of the ground floor and the upper floor, which is millhouse [21]**

Watermills

Roman Grishman, in his book of *Human's Art,* described the watermill system as the oldest archaic watering system in the world and considered it to be of 1400 to 1500 years age. The recent studies corroborate the oldness of these watermills that was estimated by Grishman, too [14]. Near Dez River and in the rural area of Dezful, parts of a ruined installation is observed, which are believed to be 1700 years old and have their roots in Sasanid period. These watermills operated until 1968 and the city dwellers called them OsiyoRa'na. However, OsiyoRa'na was a name only attributed to the watermills under New Bridge. All of these watermills are similar in the overall appearance of building and their building materials. Unfortunately, only a few of them are remained along the Dez River, which passes through the city. That is, in the region 3 of the city, a number of the windmills have survived but because of being obsolete are under the process of decay and even some of their elements are already destroyed [15]. As a matter of fact, there were other watermills which existed in the past in the other areas near Dezful, but now there is no trace of them. For instance, in the eastern side of the river, in a region 100 meters away from New Bridge toward the north of the river, the ruined parts of a watermill can be seen under river water. In another region called Ra'na, about 500 meters further away from the above mentioned place, the remnant of some watermills can also be found. In general, the regions which had watermills are divided into three:

1. Old Bridge, around which the watermills can be seen
2. New Bridge, around which the watermills can be seen
3. Downstream and upstream Golegole watermills in the north of Dez River in *Alikale* region.

Each of these watermills was built in a different year. Floating watermills of Khuzestan Province and Dez River are located on the west side of Dezful city from north to south. Despite the fact that Dezful and Shushtar cities are less than 75 kilometers far from each other, the number of the windmills in Safavid period in this distance reached 50 to 60, some of which were destroyed by seasonal floods.

Lord George N Krozon (1889), in the second edition of his book of *Iran and Iran's towns*, states:

Near the headspring of river stream, some watermills are built on the big rocks, which are connected to each other by a weak bridge or pavement. These watermills operate with the stream of the river and have a very beautiful view [16].

Baron Dobed, on page 371 of his records, writes:

"A number of watermills are constructed inside the river or on the rocks in the river, where the river flows with high speed. These small islands are connected to each other. At night, when the lanterns of the watermills are lightened by the miller, a fantastic scene is created by the light"[17].

It is worth noting that some of these watermills were called "*Mirzaei* watermills" and were operated throughout the whole year. The others were called "*AbdullahMirazaei* watermills" and were operated only when the river was in flood.

The watermills were used to mill turmeric, gypsum, juniper oil, and sugar, in addition to milling the wheat. These were all done in almost all the watermills but in these watermills, in addition to milling, grinding the wheat was also done. To do this, the miller should increase the distance between the two millstones.

There was a rail, which was raised by a strap, between two lumbers. The strap and lumbers were positioned near the millstones. When the millers were taking rest, they raise the strap to prevent the millstones from rotating. The shaft, which is connected to the runner stone via the lumbers, holds the runner stone in a high position.

Iran's and the world's watermills, which are more than thousands years old, are divided into three categories, depending on their types and functional system: Norse watermill, over-shot wheeled watermill (DEZFUL WATERMILLS), and floating or under-shot wheeled watermills [18].

Sustainable architecture of the asbads

Dezful watermills are built in two floors (Fig. 4), of which the first floor was the place for the installation and the second floor was the place for grinding the wheat. The border between the two rooms was a roof, made of wood and covered by thatch. The design of the wall was in a form that wooden lumbers, with 10 to 15 centimeters width and 200 centimeters length, were put in the wall from the two ends to 20 centimeters deep in the wall. Then, it was covered by cane and the canes were covered by thatch and cane leaf. At the end, they were all incrusted by a layer of mortar or lime (Fig.4). The mortar was troweled so that it becomes smooth and uniform on surface. After drying the mortar, a smooth and nonporous surface was produced for the wheat to be collected on.

***Fig. 4.*Dezfoul watermills are built in two floors. In the lower floor, the installaions were located. The upper floor was the place that the grains were ground; [21]**

The wall façade, which formed the outer face of the structure, was made of brick, whose inside was filled with a mixture of mortar and bed river pebble which were abundantly available on the bed of the river. Sometimes, the outer façade was built with a blend of pebble and brick. This type of building administration was adopted from the style of Sasanid bridge construction in Dezful, which its remnants are visible under Dezful Bridge.

Dezful watermills were designed in two forms: doublet (or single) watermill and pair watermills (Fig.5). Single watermills were the mills which had only one millstone to operate. That is, they had one single room, called single-stone. Pair watermills were the mills which had two rooms and were also called two-stone. The two rooms were separated from each other by a blade of brick wall. The general aspects of all of these watermills are the same, a two-floor structure with a ship-like nose (Fig.5).

All the watermills were connected to each other as well as the river bank by some bridges. With these bridges, people could carry their wheat, barley, or other grains by horse or other cattle to exchange with flour. The point is that the cattle were stopped near the bridges and, for the rest of the way, the packs of grains were carried by the workers, because the bridge paths were narrow and the cattle could not turn around on them. Dezful watermills were all constructed on the bed of Dez River, which has a conglomerate structure. The hydraulically powered structure on the Dez river bed is considered among the firmest conglomerate structure, which in rigidity is similar to concrete.

The materials, which were used in the structure of the watermills, should be very resistant against humidity and, therefore, were mostly river bed pebbles, brick, mortar and wood. The basis of the structure of these watermills is made of thatch, ash, and brick. The bricks are arranged in three rows and, in some parts, the basis is made of one row of stone. The walls of the structure are made of brick, river bed pebbles, and mortar. The brick sizes are about 7×24×24, 4×18×18, and 3×20×20 centimeters and their colors are yellow and red. The Soil of the brick was supplied from the mines around Dezful city and, then, was baked (Fig.6).

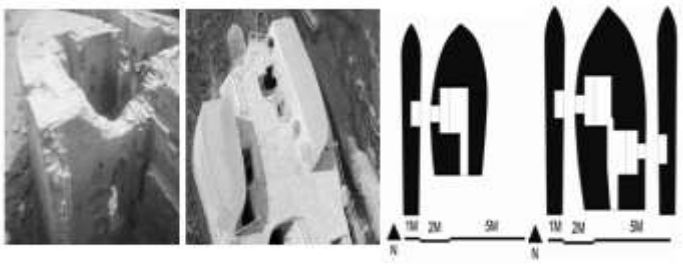

***Fig.5.*Dezfoul watermills were built in two forms, signle watermills and coupled watermills. The nose of the wave breakers were likethe prow of a ship so that the watermills could resist against the powerful flow of the river [21]**

The method of constructing Dezful watermills was called *Sak*. In this method, to construct the wall, all around it was casted by building materials such as brick and mortar. Then, inside the area which was surrounded by brick and mortar, mortar was casted. At the same time river bed pebbles in a non-cast form (or floating) were thrown in it. As a result, the speed of administration of work picked up and a structure similar to the conglomerate structure of the river bed was formed [24].

The outer crust of the walls and Dezful watermills, as was mentioned before, is usually made of brick, but in some parts a mixture of river bed pebble and brick was used. This unique style of wall building is derived from architecture of Sasanid period. The bases of this watermill-bridge, which are built in Sasanid style, can still be observed (Fig.6). To fill the curved parts of the structure, the pieces of crushed bricks were used rather than river bed pebble. This was specifically done to create a new style on the curved lines. All the watermills are in harmony in respect to their structure, construction, and appearance and they follow a certain type of architecture.

In Dezful, midstream watermills were mostly used in spring and summer and the watermills of the river bank in winter. In the seasons which amount of fall was decreased, midstream watermills were used because the river flow in this type of watermill was stronger and they operated in both summer and winter. But, in the seasons that the stream of water was elevated and midstream watermills went under the river water, the watermills of the river bank were used. In other words, the reason of operating midstream watermills was the low level of river water and the reason of operating river bank watermills was the high level of river water. Hence, the miller had to transfer their watermill installation in different seasons (winter and fall versus spring and summer) to prevent them from destroying as a result of river spate [25].

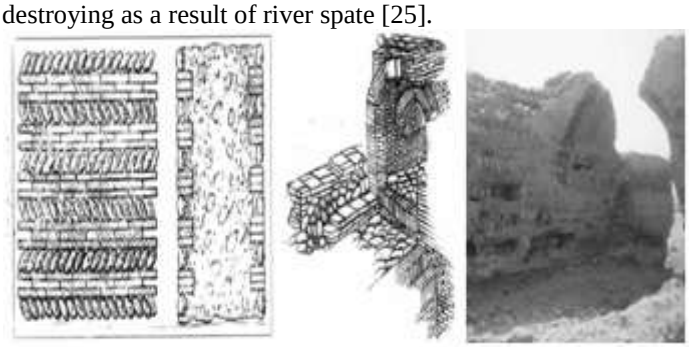

***Fig.6.* The details of Dezfoul watermills; the view and a profile of the Sasanid Bridge structure in Dezfoul, which was used in constructing the watermills walls [21]**

The function of watermills as bridges in dezful

Dezful watermills are located on a sedimentary and conglomerate bed of the river (Fig.7) and are extended on the width of the river successively. Today, the remnants of the watermills can be seen under New Bridge. The arrangement of the watermills was in a way that they act like a dam to direct the river flow to a certain direction. This structure was a Sasanid developed one, which made a cut on the first part of the river and was called bridge OR *Dambraj*.

In some cases, the connection path of old watermills turns to be a part of that of new structures on the river (the example of such phenomena is seen under the New Bridge of Dezful). By considering the seasonal operation of beside and inside river watermills as well as the extension of watermills to New Bridge and the status of the ruined part of the midstream watermills, we arrived at the conclusion that one of the main reasons of building such watermills was to create a path between the two banks of the river, specifically in the current locus of New Bridge. Regarding the fact that one of the main connection path between resident area and the existing watermills were founded alongside of New Bridge, the above mentioned probability increases. The creation of a raw of bridge-like watermills along New Bridge indicates that accounting the constructed watermills a connective path is sensible (Fig.7).

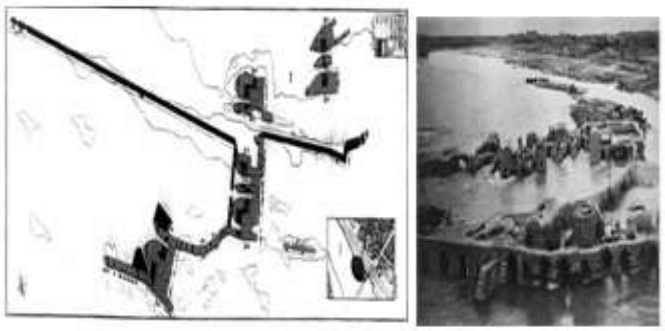

***Fig.7.*Dezfoul watermills-Bridge in a chain-like arrangement, extended on the width of the river, in 1967 [20]**

Mechanical system of the elements and parts of the watermills

Most of the watermills in Iran are of Norse type. However, there are some over-shot wheeled watermills and Dezful's watermills are of floating (or under-shot wheeled) type. Dezful's watermills are composed of the following parts:

1. Steel shaft
2. Wooden horizontal shaft
3. Wheel paddle
4. *Gorgor*
5. Gorgor cogs
6. Roller bearing
7. Dule
8. Upright shaft
9. bedstone
10. runner stone

Water enters the reservoir, in which wheel paddles and *gorgor* as well as other elements are located, via the sluice gate. Note that the place where the wheel is stored is called *slope* and where *gorgor* is kept is called reservoir. Water level should be about 70 to 80 meters (with the volume of 220 cubic meters) so that water can move the wheel(Fig. 8).

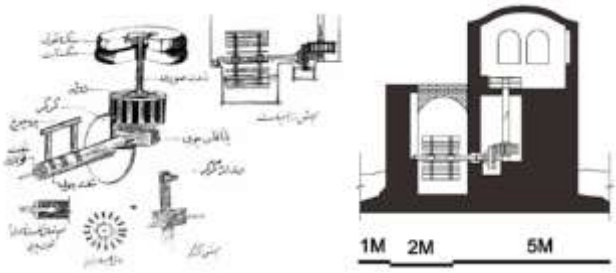

***Fig.8.*The details and aprofile of the mechanical system of Dezfoul watermills [21]**

Example of watermill

Ra'na watermill

Next to Golegole watermills and near the place that is today called concrete New Bridge in Dezful, a row of numerous Roman arches as well as stone and mortar walls with 1.30 to 1.70 meters thickness, small and big mouths, and half-ruined rooms is observed. They are built in the river width and a wall with 150 meters circumference is built round the north side of the river. This wall is attached to another wall with 15 small bridges inside from the left end and is dived into four separate parts from the right end. These four parts are 3 meters far from each other. The north view of the foundation is like a ship prow and some rooms and sluice gates can be seen on it. Each room has two sluices, each connected to a hole, with narrow and wide parts in its inside (Fig. 9).

***Fig.9.* Ra'na watermills [21]**

Koli watermills

Today, Ali Koli brook, on which the watermills were built, is dry. Interior buildings of the structure of watermill indicate the elegancy and delicacy in their construction, room designing, and earrings-like style of the structure. There is no building or wall surrounding the structure. The sizes of structure bricks, which are very old, are 17×17×3.5 centimeters. In some parts of the structure, ionized bricks are used. Interior parts and rooms include two or three floors, which are made of adobe and are covered by thatch and the whole structure is 6.10 meters wide and 13.7 meters long. There is a sluice, made of brick and mortar, in northwest of the structure.

Conclusions

Sustainable architecture like other architectural issues has its own principles and rules. Generally, it has three characteristics:

1. saving resources
2. being designed to return to the life cycle
3. being designed for man kind

For each of the above characteristics, some special strategies are considered. Investigating the forgotten structures such as windmills and watermills in Southeast and Southwest of Iran shows that inherent features of the historical and traditional areas of Iran correspond to the latest scientific findings. It seems that this harmonyis resulted from long and repeated trials, which were done throughout the construction of the structures and city installations. With regard to the point thattraditional architecture

of Iran in desert areas as well as hot and humid areas has a very powerful and widespread support invarious aspects of designing, examining these featurescan be to the benefit of city planning and designing and publicizing the living environment. Therefore, studying traditional architecture from sustainability point of view and reflecting on its the positive points and its capacities to accommodate with today's life and taking the advantages of technology in designing structures give us the opportunity to continue the exisiting trends to harmonize and combine this traditional architecture with the modern life in order to take more steps on sustainable developments.

1. The main reason for using the windmills by the residents of Sangan, Neshtifan, Khargard, and Khaf was that the north winds blow throughout the whole year. In fall and winter, all the provinces in Iran are in the path of the winds. In spring and winter, at least in the eastern part of Iran, from Sistan to Ghuhestan, the wind blows. In Taybad and Khaf, 120-day winds blow from the middle of April to July, with a very high speed. The other reason for using the mills was the shortage of water, which made the people to use wind energy to mill the wheat. In Khaf and Zouzan, the mills are considered as the vital element of the buildings. They, more important than the doors and walls of the building, display the special and noble values of that time. Windmills are not built separated from each other. In other words, they are put near each other to prevent the strong winds from destroying them. Consequently, the mills form a set in a wide area in order to increase their resistance against the winds. Also, they provide a center for the farmers to be together and have a chance to trade the wheat, after the harvest.

2.the structures that we call watermill did not function as watermill from the beginning. From the archaeological point of view, when they were exploited at about 1400 to 1500 years ago, they were not only bridges which connected the two sides of the river but also regulator dams that could impound water to be later used to water the farms. However, as their structures were suitable to mill, the theory of using them as the mills cannot be easily rejected. In archaeologists' ideas, these structures were rebuilt in Safavid period and operated as watermill. In other words, they were gigantic bridges which, after making a few changes, turned to mills. Over time, some changes were made on them by the floods and other environmental factors. Their last changes are considered to be made in Safavid period, with the evolution of brick. At that time, the dimensions of their bricks turned to be 18.5×18.5×3.5 centimeters.

These sets of installation, with their complex and well-aimed design, breakwater, large walls, openings, and depressurizing tools, were constructed on the river and took river water to the surrounding pastures and farms. They could not be some simple mills, which only milled the wheat. It might be discussed that they were the structures with some special purposes whose functions were changed to milling. We might even claim that, a few years later, the mills were built on the foundation of these structures.

Regarding the two theories and according to the conducted studies, we might discuss about the multipurpose design of this installation. That is, this set of installation was used to both direct the river and function as a bridge and mill, in Sasanid period. Additionally, it was used a as playground and stay place for Sasanid commanders, as the number of milldams and the pressure of the river flow could be controlled and people could swim or boat in the river. On the other hand, two capitals of the Sasanid dynasty were Fars and Tisfoun. The link between these two capitals was established through Kohgiluye, Bakhtiari, Ranhiroz, Shoushtar, and Dezful towns, Karkhe River, and most probably Dezfulbridge. It might be claimed that the whole set was a bridge, which was built with much care and delicacy to increase the level of water behind the bridge, help the pass of the missions, water the farms, and serve as a stay and entertaining place for the commanders. In other words, it was a military path, which was also used as a place for taking rest and relaxing. We can even say that the whole set and the rotation of the mill wheels was a part of facilities for the Sasanid troops. In the openings, there are traces of a magnificent arch. Remembering the Sasanid kings' interests in this type of structure, we conjecture that it was a living place for a commander or a great man of that era.

Dispensed with the function of such structure, about which the technology of building by people of that time with that limited knowledge is questionable, what is significant is great resistance of these watermills against the flow of one of the biggest rivers in the country. To sum up, it is evident that this structure, dating back to 1400 years ago, is still firm. Its imperishability can be attributed to the engineering powerful theories of the builders of that era. They used nose-like structures in front of the whole structure so that it can act like a ship prow to cut water flow and prevent it from destroying the structure. The other cogitative technique was the use of mortar, as one of the toughest building material, to build the structure. Also, mortar, in comparison with concrete, could better increase the resistance of these structures against water flow.

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