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Ab-anbar, sustainable traditional water supply system in hot arid regions, remarkable example of Iranian vernacular architecture

Amin Saeidian

Department of Architecture, Mahshahr Branch, Islamic Azad University, Mahshahr, Iran.

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ABSTRACT

The use of cisterns in Iran has been diminishing rapidly due to the widespread use of piped water and household refrigerators. Except for a few cases still in use, most of these cisterns so-called "Ab-Anbar" have either given way to new developments or have been re-modeled as tourist attractions. Ab anbar (آب انبار) means 'water storage' in Persian. An ab-anbar is a traditional type of reservoir that was commonly built in pre-modern Iran. As the modern life and technology dominated the region, water pipeline system replaced cisterns. Supplying potable water in hot arid regions has always been a challenge for the residents. In central and eastern deserts of Iran, where poor rainfall and seasonal rivers cause extreme conditions in supplying water, a creative traditional solution has been a unique kind of water reservoirs (cisterns) called “Ab-Anabr”. These structures typically consist of an underground cube or cylindrical reservoir with a massive covering dome and one or more wind towers for ventilation and a staircase for taking water. Ab-Anbars were often constructed by first digging a cylindrical or sometimes rectangular tank deep into the ground--sometimes as far as twenty meters. The walls of the tank were lined with bricks using a special type of mortar called sarooj that was considered to be completely impermeable to water. The tank was then covered with a dome that protected the water in the tank from evaporation and contamination from windborne dust and bird droppings. The windcatchers that projected from the dome allowed for dry desert air to flow into and out of the dome, performing the dual functions of cooling the water and preventing condensation from forming on the inside of the dome, which could potentially lead to mildew and other hygenic concerns. Purity of the water was further maintained by isolating the main tank entirely from human contact. Water could only be obtained from the cistern by descending a series of steps runnning adjacent to the tank. Taps near the top of the stairs provided warmer water, while the coolest water could be obtained by descending to the bottom of the stairs and extracting water from taps at the base. Ab-anbars were so important to life in desert regions that they often became integrated into structures built atop them, such as caravanserais or mosques.

Introduction

To efficiently collect and reserve water has never been any possible task to do unless a great amount of experience has been gained throughout centuries. Supplying water by kariz (qanat) (Fig.1), man-made subterranean aqueduct system, has been common in ancient Iran. Water supplied in this way must be kept in an appropriate structure, a water reservoir (Fig.2). Water reservoir is a deep circular insulated pit covered by a dome and accessed by a stairway leading down to its entrance. A barrel-vaulted ceiling covered this stairway [1]. Water could be kept cool and clean with the help of some local techniques.

The natural and climatic characteristics in addition to the expanse of Iran's deserts have given rise to the construction of various reservoirs. Most of which have been built at the center of the localities of the cities and include four main elements such as: Khazineh or hot bath, dome, the foot or faucet and a wind trapper [2]. The reservoirs of the bath have been designed in the form of cylinder inside the ground in order to give a vantage point to the water of subterranean canal and also to keep the water temperature low. The dome was built in a semi-circular shape over the reservoir in order to prevent water from environmental pollution and keeps it cool. The foot of faucet has got a stair-like corridor or passageway for taking water from the reservoir and the wind trapper was a means of air circulation in order to prevent the water rotting or becoming putrid. Ab anbars were the terminal point for many kareez, the underground water channels that bring water, in this case, for urban consumption. The water stored in these storage facilities is then individually collected for personal use [3]. The wealthy or otherwise fortunate had and has private storage facilities - as well as cooling systems attached to the kareez. The common person had to come and collect water from the ab anbar. For this reason, it was essential for ab anbars to be located in each neighborhood within walking distance of the eventual user. The individual user did this by descending steps into an ab anbar, and filling a water container with water which they had to carry back home. Alternatively, water carriers made a living by delivering water from an ab anbar in a goat skin bag strung over their shoulders. The water carrier would go from door to door offering to sell water to a householder [4].

Tele:
E-mail address: amino_saidiano@yahoo.com

Fig.1. A qanat near Anšan, seen from the air (Google Earth).

Fig.2. Historic photos of solar water storage, 1970 (Google Earth).

The technology that goes into the construction of these ancient structures is not so evident at first glance but quite amazing once we start an examination. At the outset, the ab anbar needed to be strong enough to withstand the huge pressure exerted by the water stored. A related need was the ability of an ab anbar to be earthquake resistant since the region is beset by violent earthquakes. Both needs were met by constructing the storage below ground, a required feature since the water flowed by gravity from the water tunnels of the kareez into the anbar. The thick brick walls were also superb insulators, preventing warming and freezing of the stored water. The ab anbar structure was constructed using special materials. The walls of the storage, commonly two metres thick, were built using specially baked bricks called ajor ab anbari. A special mortar called sarooj was used the bind the bricks, and it was made up of specific proportions of sand, clay, egg whites, lime, goat hair, and ash. The mortar component proportions were custom formulated for different areas and climates. The resulting wall was water-proof and earthquake resistant as well. Large ab anbars that served single large users such as caravanserais or places of worship were built directly under the edifice. Depending on the location, ab anbar construction technology was incorporated with the badgir (wind catcher) cooling technology. Where needed, one to six badgir towers (Fig.3) provided ventilating and cooling to prevent air stagnation and humidity accumulation air thereby preserving the integrity of the water and a year round supply of pure, clean, cool water.

These structures are usually located in the center of the city neighborhoods and made up of four main parts: the underground reservoir, the pasheer or platform, the dome, and the badgir or wind catcher shafts.

1-A reservoir, which is cylindrically shaped and below the ground surface. The water, coming from underground canals, pours into this reservoir;

2-A dome built over the reservoir, which keeps the water cool;

3- Pasheer, the platform, which is used for taking water from the reservoir;

4- Badgir, a weathering shaft for bringing in the air current in order to protect the water from spoiling (Fig.3).

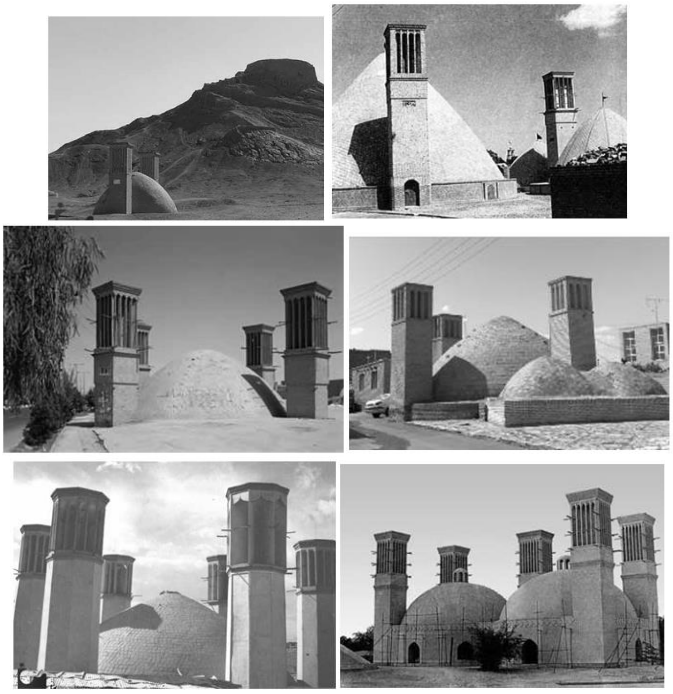

Fig.3. (right top) a one badgir towers, Naeen, (left top) two badgir towers, Kish, (right middle) three badgir towers, Isfahan, (left middle) four badgir towers, Yazd, (right below) five badgir towers, Kish, (left below) six badgir towers, Yazd,Iran, Ab Anbar.

Some of the larger and centrally located ab anbars also house a khazineh or public hot bath. The cylindrically (Fig.4) shaped underground chamber often 10 meters below street level, maintain a stable low water temperature considerably below the summer sun baked ground surface [5]. A descending staircase passageway approached the pasheer or foot of the faucet used to retrieve water. The semi-circular brick lined dome, visually much alike a Buddhist stupa, have escape vents in the center to cool water by air convection while protecting it from dust and other pollution. Four adjacent badgirs or weathering shafts, often at the cardinal directions would maintain fresh air circulation to prevent water quality deterioration (Fig.5). The hierarchy of urban space where anbars were sited would determine both its size and the scale of constituent elements. Thus, minor neighborhood anbars are usually endowed with fewer badgirs while larger, city center reservoirs are often serviced by six or more wind catchers. The access openings to the street were often decorated with intricate stalactite ornament while larger anbars often housed shops and coffeehouses in addition to public baths signifying an urban institutional status. Not infrequently bazaars, mosques (Fig.6), public baths and anbars would function together within a waqf (religious endowment) property [6].

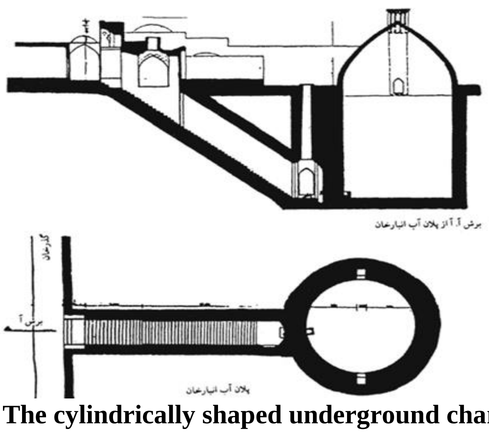

Fig.4. The cylindrically shaped underground chamber maintain a stable low water temperature.

Ab anbars played a pivotal role in determining both Yazd's skyline and urban layout but are in a precarious state of preservation today with redundancy caused by modern piped water supply systems. Though few of the architecturally significant examples can be preserved, sustainable strategies to conserve traditional urban infrastructure systems like qanats, badgers, pigeon towers, dams and water mills need to be explored [7].

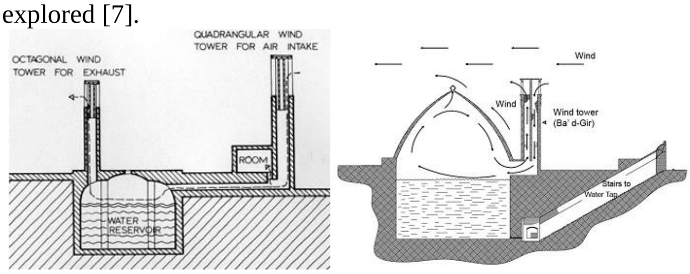

Fig.5. A section of cistern and its surrounding soil with wind-induced air flow over the water surface

Before piped water became popular, many houses in Iran use the river water which was stored in community cisterns in winter. These cisterns were filled during the winter nights with coldest possible water. Before entering the cistern, water flowed in open channels where it was cooled evaporatively and by radiation heat transfers to the clear sky, to temperatures only a few degrees above the freezing point. Water remained in the cistern until summer or when people need cold water for drinking. Then, people desiring cold, potable water walked to the community cistern and took the needed amount of water for their use. Water was removed from the bottom at a very low rate (less than 30L per min) so that there was no disturbance in the thermal stratification of water in the cistern. Furthermore, because of their very large sizes and thermal stratification, the rate of heat gain by a unit volume of water in these tanks was very small. The cisterns could then supply water at low enough temperatures for drinking [8]. The size of the cisterns was dependent upon the size of the community they were serving. It varied between about 500 to about 5000, with 2000 m3 designating a more common size. The height of the cisterns varied from about 5 to about 10m. "Masum Khani" cistern with the capacity of 2500 m3 is considered an average cistern. The brick walls and floor of the cisterns were lined with an indigenous cement to prevent water leakage [9].

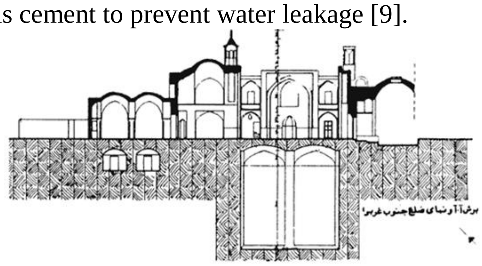

Fig.6. The Ab anbar is situated below the osque,Kashan,Iran

History And Origion

The term āb-anbār is common throughout Iran as a designation for roofed underground water cisterns. In Turkmenistan the term sardāba is found for similar structures [26]. Early Islamic sources in Arabic appear to use the words eṣṭaḵr for a covered tank or cistern [27]; and in 14th to 16th century texts, maṣnaʿ can be understood as designating a cistern [28]. The āb-anbār was one of the constructions developed in Iran as part of a water management system in areas reliant on permanent (springs, qanāts) or on seasonal (rain) water. A settlement's capacity for storing water ensured its survival over the hot, dry season when even the permanent water supply would diminish. Private cisterns were filled from qanāts (man-made underground channels) during the winter months before the floods, while surplus flood water could often be stored in open tanks, as well as in the large, public, covered cisterns [10]. Water was brought to the cisterns by special channels leading from the main qanāt or holding tanks and was controlled by sluice gates. The āb-anbār, a ventilated storage chamber, could then provide cool water throughout the summer months. Often rooms or pavilions were built within the complex of the cistern to provide a comfortable resting place as well. While private houses may have had their own cisterns, filled in turn from the qanāts or streams, in desert towns like Yazd or Ṭabas the more noteworthy and elaborate structures were built for public use, often as part of a vaqf, within towns as well as on caravan routs [29]. Two types of structures have been noted, a cylindrical reservoir with a dome and a rectangular one supported by piers or pillars [30]. Each was marked by a portal, often with an inscription giving the name of the benefactor (builder or repairer) and the date [31]. The portal opened into a steep, barrel-vaulted passageway, leading down to the reservoir.

Although a detailed study of all variations of construction techniques of the āb-anbār in Iran still remains to be done, Grazhdankina's analyses of similar structures in Turkmenistan, as well as observations by Beazley, Wulff, Siroux, and Sotūda, allow a general outline of the technique. The prime objective in constructing an āb-anbār is to provide a totally waterproof container for a large volume of water while allowing for proper ventilation and access. The excavation was lined with overfired brick set into a sand and clay mixture. It was then covered with a layer (about 3 cm) of waterproof mortar, sārūǰ . Larger cisterns were often lined with an additional double layer of bricks, covered with another layer of sārūǰ of slightly different composition, and finished with a hard plaster coat. The early history of covered cisterns in Iran has not been studied, although it is possible that a major elaboration of construction techniques may have taken place during the Parthiann and Sasanian periods, when water management constructions (dams, weirs, qanāts) were built extensively. The geographers of the 10th century apparently described a fully functioning system of cisterns. The Ardestān desert road, as well as the road from Isfahan to Nāʾīn, was lined with open tanks and domed cisterns. In fact, these domes often served as the only sure markers on desert routes. ʿAżod-al-dawla (A.D.943-89) built an enormous vaulted cistern at Eṣṭarḵr. Investigations in the ceramicists' qaurter of 11th-12th century Marv have revealed a cistern located in close proximity to the mausoleum of Moḥammad b. Zayd. Its cylindrical reservoir had a 6.1 m diameter, and was apparently ventilated by a pair of window-like openings. Its covering has not survived or may not have existed. The cistern next to the rebāṭ al-Taḥmalaǰ, datable by its brick size to the same period and covered by a dome (17 m in diameter and 8 m deep), had a capacity of 150,000 liters [32]. Similar structures have been found recorded by Masson on the major desert routes of Central Asia and Turkmenistan, though most extant examples are of a considerably later date. The cistern associated with the 861/1456 mosque at Anaw is 6,5 m in diameter and was fed by three channels. Regional surveys of the Yazd and Kāšān regions have listed scores of āb-anbārs, located either within settled areas or along caravan routes. While there are one or two earlier ones, most are dated or datable to the 18th and 19th centuries [33]. The earliest dated āb-anbār is in Yazd, behind the masǰed-e ǰāmeʿ, and is dated 878/1473. Āb-anbārs of the Safavid and later periods were built with two or more ventilating towers (bādgīrs). The āb-anbār of the moṣallā at Nāʾīn, most likely a nineteenth century building, illustrates the typical use of the towers for the ventilation, as well as the relationship of the cool room pavilion to the āb-anbār. The āb-anbār of Ḥāǰǰī Sayyed Ḥosayn Sabbāḡ in Kāšān dated by its inscription 1240/1824 is a more elaborate example of a rectangular hypostyle type. Built within the main bazaar, it has a large portal decorated with moqarnas and glazed brick and tile inlay. A set of pavilions or rooms built above the reservoir and cooled by it has a separate access from a series of workshops [34]. The use of bādgīrs was particularly well developed in Yazd, where there are several āb-anbārs with four bādgīrs as well as the famous āb-anbāršaš-bādgīrs with six.

Construction

To withstand the pressure the water exerts on the containers of the storage tank, the storage itself was built below ground level. One important aspect to consider here is their resistance to earthquakes. Many cities in Iran lie in a region that have been struck with massive earthquakes. However, since almost all ab anbars are subterranean structures capped barely above ground level, they inherently possess stable structures [12].The construction material used for ab anbars were very tough and extensively used a special mortar called Sārūǰ made of sand, clay, egg whites, lime, goat hair, and ash in specific proportions, depending on location and climate of the city. This mixture was thought to be completely water impenetrable. The walls of the storage were often 2 meters thick, and special bricks had to be used. These bricks were especially baked for ab anbars and were called Ajor Ab anbari [13]. Cisterns are built in towns and villages throughout Iran, as well as at crossroads, caravanseries, and hospices (rebāṭ) [14]. While town cisterns may be filled with rain water or from qanāts, most āb-anbārs along caravan routes are filled from the spring torrents of nearby streams; during the dry season gradient weirs are constructed in the stream bed in order to divert water to the cisterns when the winter snows melt and the streams rise. Use of two or more cisterns becomes necessary when the volume of water is large [15]. As one cistern becomes full, the water collecting behind the weir can be directed into a second cistern by diverting it into a second channel dug alongside the first, as this channel is opened and the other closed off. Should this channeling system fail to draw off a sizable enough volume, the water would built up behind the weir and eventually destroy it [16].

Mode Of Construction

Cisterns built inside private dwellings are usually square or rectangular (Fig.7); public cisterns in towns or along the caravan routes are generally round. While the former have a flat roof (Fig.8) and are often built into the foundation of the house, the latter have a distinctive hemispherical or almost conical roofing.

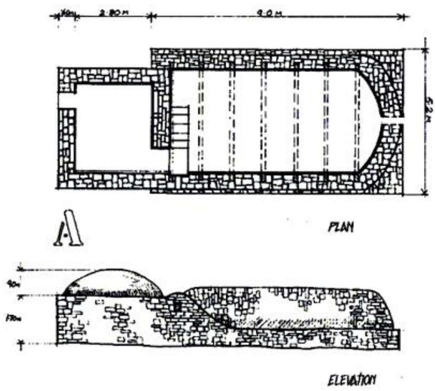

Fig.7. Cisterns built inside private dwellings are usually square or rectangular.

Fig.8. an ab anbar with flatten roof, Boshehr, Iran

Water remains quite cool inside the cistern, since it is generally built beneath ground level and is insulated by very thick walls. In most parts of Iran, but particularly in the south, one or more ventilation towers (bādgīr) is built along the edge of the cistern's roof, directly on the tank wall and connected by a duct to the upper part of the cistern chamber under the domed roof. Fresh air entering through these ducts keeps the air inside the cistern chamber circulating and the water cooled [17]. The six-ventilator cistern to be found in the city of Yazd is probably the most elaborate example of the type equipped with ventilation chambers. In the case of cisterns with domed or conical roofs, the center of the roof is sometimes pierced, and a short ventilation chamber made of brick is built directly over the cistern chamber. A duct inside the ventilation chamber leads from the openings or slats (that catch the breeze on top) directly inside the roof, again circulating air inside the cistern chamber. The height of these ventilation chambers is generally about one meter, though some can occasionally be seen that reach a height of two or even three meters.

Construction

Materials used consist essentially of stone or baked brick with lime-mortar and plaster. After the pit that will house the cistern has been hollowed out, the bottom is covered with slaked lime-mortar. When this floor hardens, the builder erects the tank's walls, made of baked brick or stone. The bricks are generally plunged in water before being laid. The filling between bricks or stones consists of lime-mortar. After the roofing of brick and slaked lime is laid, the tank's floor and walls are finished with a coating of plaster [18]. A type of cistern called rīḵtaʾī ("poured," i.e. made of poured lime-plaster) is considerably cheaper to build. First the perimeter of the tank's walls is marked out, and the earth within the wall area is dug out to the desired depth. Next lime-mortar is poured into the square or rectangular trench until it is filled nearly to the ground level. This is left for a week or two until the mortar settles and is solidified. Then the area of earth bounded by the mortar walls is dug out down to the desired floor level. The floor is built by pouring lime-mortar; and, finally, when the walls and floor are dry, they receive a coat of plaster [35]. Plaster is an indispensable material in the construction of the Iranian cistern, since the essential function, containment of water, is achieved by the watertightness of the plaster. The type of plaster most commonly used, called sārūǰ, is a compound from six parts clay, four parts lime, one part ash, and an amount of lūʾī sufficient to keep the compound from cracking; this last consisting of the seeds and pods of an extremely soft and pliable species of reed. The first step in the preparation of this plaster is the mixture of the clay and lime, to which water is added. All of this is made into a relatively hard, clayey substance which is worked for one or two days. Next the ashes and lūʾī are pounded into this mixture until the various components have been thoroughly blended. This pounding is done with wooden sticks about 10 cm in diameter and one meter long, one end of which has been tapered to serve as a handle [36]. This last step is important, because the more the mixture is pounded and kneaded, the more durable it is. When the plaster compound is ready, it is spread on the walls and the floor of the cistern with a trowel. The next step is to score the plaster surface with a lentil-shaped stone that fits in the palm of the hand and is called a mohra ("bead"). This scoring goes on for several days until the walls and the floor of the tank begin to perspire, a sign that the components in the plaster are holding together fast. Only then is the cistern filled with water.

Drawing Water

Cisterns may be provided with a tap. When the place for the tap is reached in the course of construction, an additional pipe for it is built into the wall; and a plaster compound (half clay and half lime) called "bastard clay" (gel-e eḥarāmzāda) is pounded with the feet into the space above the pipe [37]. Water is taken from this type of cistern by means of a separate chamber, containing a staircase, about as deep as the adjoining tank chamber. The stairs are wide enough so that persons going up and down with buckets, gourds, or leather bottles will not get in each other's way. Two, three, or even more taps are sometimes installed. A few cisterns have been observed to have two separate stairs on opposite sides. In the case of the cisterns built alongside roadways, however, the normal procedure is to construct the staircase within the cistern chamber itself, so that the water is drawn directly from the tank.

Capacity

The capacity of the traditional cylindrical cistern varies generally from 300 to 3,000 cu m. This upper limit is dictated by the fact that the maximum diameter allowed by the method of construction is about 20 m. If the depth of the tank is up to 10 m, its capacity would be about 3,000 cu m. In a few localities the cisterns have an even greater capacity, and some exceptional examples have been cited as able to hold up to 100,000 cu m. These are not round tanks, however, but square or rectangular cisterns with columns placed in the middle of the tank chamber in one or two rows [38]. These support a roof consisting of a series of domes or barrel-vaults.

The Storage Tank

Some ab anbars had storage space tanks that were rectangular in design (Fig.9), such as in Qazvin, as opposed to cylindrical designs in Yazd. There were several designs for the arched roof of the storage spaces of each ab anbar, namely ahang, kalanbu, kazhāveh, or combinations of these depending on the features of the storage space [19]. In the particular example of Sardar-e Bozorg ab anbar in Qazvin, the storage space was built so large that it became known as the largest single domed ab anbar of Iran [21]. Doming the square plan was not an easy task, yet dome construction was not something new to these architects as is evident from the numerous domed masterpieces such as Soltaniyeh. Some sources indicate that the architects would first construct the storage space and then fill it up with hay and straw all the way up to where they could start constructing the dome. After finishing the dome, the straw would be set on fire, hence clearing the space inside. However holes can be seen in the walls of many storage spaces where scaffolding perhaps may have been used [20]. A storage space with a rectangular plan is much harder to dome than a cylindrical one. It is not known why architects in particular places chose perpendicular plans or cylindrical ones, considering that cylindrical spaces were easier to cover, and were deemed more hygienic for water storage due to lack of any corners in the space [30]. Cylindrical tanks also had the advantage of containing a homogeneous pressure, as opposed to the rectangular designs. Rectangular plans however may have had the advantage of employing larger spaces. The Zananeh Bazaar ab anbar of Qazvin uses 4 columns inside its storage tank. The Seyed Esmail ab anbar in Tehran for example, is said to have had 40 columns. Some ab anbars such as the Sardar-e Bozorg ab anbar in Qazvin by Sardar Hosein Qoli Khan Qajar and his brother Hasan Khan Qajar employed a square plan. Others are rectangular in plan. Some required columns to be built inside the storage space. The Sardar e Kuchak ab anbar in Qazvin for example, uses a massive column in the center that splits the space up into four 8.5 X 8.5 meter contiguous spaces, each separately domed. The bottom of the storage tanks were often filled with heavy metals for various structural reasons. The 18th century monarch Agha Muhammad Khan, is said to have extracted the metals from the bottom of the Ganjali Khan public baths to make bullets for a battle.

Fig.9. Massive column in the storage tank splits the space up into five contiguous spaces, Boshehr, Iran

Accessing The Ab Anbars

In order to access the water, one would go through the entrance (sar-dar) (Fig.10) which would always be open, traverse a stairway and reach the bottom where there would be faucets to access the water in the storage. Next to the faucet would be a built-in seat or platform, a water drain for disposing water from the faucet, and ventilation shafts. Depending on where (i.e. what depth) the faucets would be, the water would be colder or warmer. Some storages would have multiple faucets located at intervals along the stairway. Thus nobody had access to the body of water itself, hence minimizing possible contamination. The storage is completely isolated from the outside except for ventilation shafts or windcatchers. To further minimize contamination, the storage tank's interior was scattered with a salty compound that would form a surface on top of the water. The storage tank would then be monitored year round to ensure that the surface had not been disturbed. The water of course would be drawn from the bottom using the pasheer [22].

Fig.10. The sar-dar of the ab anbar of Haj Kazem in Qazvin, as sketched by French explorer Dieulafoy in the mid 1800s.

In some ab anbars, such as in Qazvin, the stairway and storage would be constructed adjacently alongside each other, whereas in Yazd the storage and stairway often had no structural connections to each other and the stairway was positioned independently [1723] The number of steps would depend on the capacity of the storage. The Sardar-e Bozorg ab anbar, for example, has 50 steps that would take the user to a depth of 17 m below grade. Nabi mosque ab anbar had 36 steps, Haj Kazem 38 steps, Jame' mosque 35 steps, and Zabideh Khatun with 20 steps (all these are in Qazvin). To provide a brief relief when traversing the steps, there would be one to three landings built midway into the stairway. All stairways are linear. The person responsible for filling the ab anbars (both private and public) was someone called a meerab. In effect, he was responsible for distributing the kariz network at various times. If a house wanted its ab anbar filled, they would ask the meerab to open up the kariz to their ab anbar. An overnight appointment would be enough to fill a typical house ab anbar. The ab anbar would also have to be cleaned once a year from settled sediments.[5]

The Sar-Dar

The Sardar (ردرس) is an arched entrance that descends down into the ab anbar. It contains platforms built-in for pedestrians and a resting area after ascending out of the stairway. It is decorated and has inscriptions with poetry and the date of construction [24].

The Windcatchers

Ab anbars in Iran are known to have used anywhere from one to six windcatchers. Qazvin's ab anbars however, do not frequently use windcatchers like in other parts of Iran, perhaps because of climatic conditions; Qazvin has very cold winters and mild summers, unlike Yazd. Most of Qazvin's ab anbars are only equipped with ventilation shafts or semi-windcatchers. Ab anbars in Yazd, Kashan, Naeen, and other hot climate cities of Iran on the other hand extensively use windcatchers for cooling and ventilation purposes [25]. The way windcatchers work is that the moving air masses (wind, breeze, etc.) at the top of windcatchers create a pressure gradient between the top of the windcatcher and its base, inside, at the bottom of the shaft. This pressure gradient sucks out rising hot air from inside the shaft while the colder dense air remains. The superb heat resistant material of the walls of the ab anbar further create an insulating effect that tends to lower the temperature inside an ab anbar, similar to a cave. The ventilating effect of the windcatchers prevent any stagnant air and hence any dew or humidity from forming inside, and the overall effect is pure, clean, cold water all year round.

Glossary of terms for ab anbar

Ab-anbar رابنا بآ: Literal translation: Ab meaning water and Anbar meaning storage facility. A specially designed subterranean space that holds clean water, usually employing windcatchers and fed by karizes.

Gushvār راوشوگ: Something that occurs in symmetrical form on both sides of an element e.g. two little rooms on the sides of a hall, entrance, etc.

Kariz زيراك: An underground water channel similar to a Qanat.

Layeh-rubi: The periodic cleansing of Qanats, Karizes, and Ab anbars from sediments that gradually settle as water passes by.

Maz-har رهظم: The first location where a Kariz or Qanat surfaces.

Meerab بآريم: A person who was responsible for distributing (providing access) water into ab anbars via underground channels such as Qanats.

Nazr رذن: A type of prayer in which a person asks for a favor in return for making a promise to a sacred entity.

Pasheer ريشاپ: The lowest point of an ab anbar stairway; the location where a faucet is installed to provide water from the ab anbar storage tank.

Qanat gnitanigiro yllausu ,sllew detcennoc fo metsys A :ق نات from elevated locations that direct water to locations far away via underground channels to a lower elevated maz-har.

Saqqa-khaneh هناخاقس: A place (usually an enclave in an alley) where candles are lit and prayers (or nazr) are made.

Sar-dar سَردَر: A gate-like entrance to a building, ab anbar, etc. The over-door decorations of this entrance.

Sarooj جوراس: A special mortar made of sand, clay, egg whites, lime, goat hair, and ashes in specific proportions, and was very resistant to water penetration.

Conclusion

Water reservoirs, or Ab anbars as they are locally known, form the terminal end of extensive traditional water supply systems that make urban settlements possible in the Kavir desert region of Central Iran. Snow fed streams were tapped at the foothills of surrounding mountains and channeled through sloping subterranean canal systems (Qanats), often over great distances to discharge into underground reservoirs within the city. These reservoirs were usually built at the center of city neighborhoods, and thus configure urban morphological form much in the same manner as their feeder canals (Qanats) configure agricultural tract divisions. Hydrological, climatic and social criteria overlapped to evolve a distinct architectural form for these water reservoirs architectural heritage and identity of cities that belong.

Traditional building techniques are particularly important because they are the result of centuries of development and practice. The recording of craftsmanship is extremely vital, not only because it provides empirical evidence of original practice, but also because it can be directly applied to practical conservation. Employing local materials in construction and repair work has many advantages, not least of which is the fact that the sources for the original materials are close to the site. Furthermore, it is explained that the workmanship necessary for using traditional materials such as mud requires more skill, sensitivity and grounding in traditional culture than what is required for modern materials. This great Iranian tradition is as yet little known in the West and there is much to be learnt both from it and the building techniques which are integral with it. It is the fate of vernacular buildings throughout the world to be neglected until they are nearly extinct. Not only is the building tradition itself still alive, but there is much to be gained from a knowledge of a highly developed technology which makes such ingenious use of natural resources without the consumption of additional power. Water collection and its storage in desert conditions and air-conditioning by means of wind-catchers are living skills which the Iranians might pass on to others. However, unless positive action is taken, most Iranian Vernacular buildings will have crumbled. Thus, In the name of Iranian architectural heritage, it is hoped that any further decay of such historical constructions can be prevented by funding.

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