

Yakhchal; Climate Responsive Persian Traditional Architecture

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Abstract. Living in hard climate regions accompany with many problems for resistance. One these problems is keeping perishable foods or preserving ice for hot seasons. Our ancestors create some ways to solve this situation that is cramped with scarcity. One of the most intellectual ways was creating ancient type of refrigerators to preserve ice- A refrigerator that can preserve ice without using any active source of energy-. This is very hard to imagine but in Iran scarcity cause an intelligent creativity and from many past centuries they wildly could product, preserve and use ice with Yakhchals. They were a pitfall in order to preserve ice. What will be presented in this paper is the investigation about this kind of refrigerator and all kinds of it.

Keywords: Yakhchal, Traditional refrigerator, Ice, Food storing, Scarcity

1. Introduction

Most regions of Iran have located in a hot and arid climate and summers in this country are very long with high temperature. Moreover, it was essential keeping meat, dairy and other kinds of foods healthy and fresh in hot weathers of summers in hot and dry regions of Iran so far has been according to the relations of ecology, so that using architectural methods based on climate, local materials and also culture has damaged the environment as little as possible. Iran's traditional architecture has been generated from a climate and the situation which it has grown on it, so that all existing spaces of these regions such as urban spaces of passages, yards, and buildings are protected against the atmospheric factors especially undesirable winds, and using desirable winds and the sun's radiation are done according to some special arrangements. People in this region tried to provide the architecture of their buildings to meets their needs and essentials. Hence, cold water was one of them that always available for people in their cities by creating ancient type of refrigerators.

The Yakhchal has been used in Iran since early times, it is one to the special masterpieces of Iran's architecture and it is also the signs of predecessors' intelligence in agreement with the climate. A Yakhchal is an ancient type of refrigerator. In Persian it means "ice pit" ("yakh" meaning ice and "chāl" meaning pit). It was provided in the coldest time of winters and kept till the threshold of the next winter to be used. Drinking cold beverages and having ice-cream can be pleasant and satisfying.

2. Ice formation

One of the basic concerns of traditional architecture in Iran was its climate in order to make a safety situation to live and suitable warmth or coldness in order to provide store and warmth, people used sun radiation and construction materials while cold winters, low temperature at nights and relative tend of earth in depths to be insulator were applied to make and preserve coldness.

Chinese stored ice before B.C, ancient Greeks and Romans made wine cold by means of pitfalls filled with straw although Hippocrates – Greek physician 4-5B.C believed that melted ice isn't sanitary. It was extraordinary and desirable for the 18th century European noblemen to preserve ice in summers On the other hand, one of the explorers stressed that the method of preserving ice has been so professional in Iran that even the poor people could afford ice [1].

Yakhchals were public, so all people could use ice. Earnest Hostler wrote about Yakhchal in Isfahan: "There were plenty of Yakhchals in Isfahan, some of them were for private use despite of this fact, and the poor could use Yakhchal to make water cool. They preserved sherbet and fruit with ice in all shops. Huge hunks of ice were carried by donkeys and sold all over the city. In Isfahan, people could buy ice either in bazaar or near Yakhchal building [2]. Since the temperature was rarely below zero in the southern parts of Iran, there was no Yakhchal there. At Caspian shores, there was no Yakhchal either because of humidity or low fluctuation of temperature. At these shores, it is very rarely to go through freezing and the temperature isn't cold enough to provide ice. But these like other regions in Iran, people condensed snow when falling, put them within the layers of wicker or straw and buried them underground to be used in summers. Unlike Ab-anbar¹ water which was sanitary and pleasant to drink, Yakhchal ice was merged with dust and soil because it was provide in open areas and also because canals and ponds were dug in the soil without any cover.

Ice is sold in places without ceiling in suburbs. People dig a deep pitfall northward and in front of it, they make a square pond with the length of sixteen to twenty and depth of around forty or fifty meter. At nights, they fill them with water and in mornings when it is completely frozen. People break the ice and store pieces of ice in the pool. They chop ice into smaller pieces because the more chopped the better frozen then. They refill these squares with fresh water like before and they splash water with sprinkler at sunsets so the pieces of ice can stick together after 8 days, with the same process they get ice 5-6 feet thick. At nights, neighbors gather to celebrate setting ice around the pitfall they play different musical instruments to get more excited. They descended on the pitfall, break ice into pieces and sprinkle water on it to stick better. By producing and gathering around six weeks, a Yakhchal building was used to be filled with ice. Snowing is very troublesome, so they row it with a shovel during snowing and put snows away from the pitfall because melting snow makes pieces of ice melt too. After filling Yakhchal, they cover it with kind of plants (bi zor) which grows on watersides [3]. In summers, they have another celebration to open the Yakhchal.

The striking feature about ice is that it is pleasantly beautiful and clean, so no dirt can seen in it. It is as clear and transparent as the spring water. Though there is plenty of ice, they preserve snow in suitable places which come in handy snow remains untouched and agreeable. These so people believe that drinks like sherbet and fruit extract are juicier with snow.

Water was provided from rivulets and qanat²s. People draw water to flat furrowed fields Or 40-50 cm deep pitfalls, as Charden has mentioned in his itinerary. Coldness of winters takes the heat of hot water away at night which ends in ice and at dawn, people transfer ice to Yakhchal in the south of the pitfalls, they make high adobe or mud walls to keep the ice in the shadow during the day, as a result, at nights, its temperature was lower than its neighboring region and water can freeze more quickly they also build shorter walls in western and eastern parts in order to prevent sun radiation at sunshine and sunset. (Figure 4)

The degree of freezing was dependent on the temperature and the amount of clouds in the sky in freezing nights without clouds, they could pour water in more depth to freeze in warmer nights or cloudy sky, the depth was less to freeze.

3. Ice preservation

Non – conductors were essential in order to keep and store ice for a long time in so doing, people preserve ice in an underground well. Three kinds of wells were prevalent in Iran that will be described as follows.

3.1. Vaulted Yakhchal

In north – eastern and central desert, people constructed a big adobe vault above wells it was like a cone beneath wells melted water was drawn into wells. (Figure 2) The dimensions of wells were different. One of the biggest refrigerators locates in Meibod. The diameter of the biggest one is 13 meters with 6 meters depth.

1 - An āb anbār is a traditional reservoir or cistern of drinking water in Persian antiquity. The Persian phrase literally translates as "water reservoir".

2 - A qanāt is a water management system used to provide a reliable supply of water for human settlements and irrigation in hot, arid and semi-arid climates.

It is surrounded by a thick vault. Vault was always surrounding made of adobe with 1.5 meters width for coming and going to provide more endurance and stability and also to lower the construction costs, the thickness diminishes from beneath to the top, so it weighs less and gravity center locates in a lower height and less material and labor force were ceded. The height of the vault in Meibod is almost 15 meters. Its thickness is from 240 cm beneath to 20 cm on the top which equals to the length of one adobe piece [4]. One of the advantages of vaults is that they have stairs, so people can keep or repair them easily. They use stairs which serves the purpose to help people cover the external crust of the vault with thatch to protect it from rain, snow, sun and atmospheric variations. They also built smaller stairs between these stairs to make it possible for workers to ply.

A shadower wall usually located in the northern part of vaults and in the northern part of this wall there was a pond for freezing water. The thickness of this wall for that vault in Meibod was 2 meters and the southern wall length was 42 meters. Eastern and western lengths of walls were 20 meters. They each often had 2 doors northern and southern. The northern one was used in winters to slide ice into the Yakhchal the southern one was opened in summers for delivering ice to people. When they unused, the doors were wadded with adobe and mud. In the southern part within the wells, a set of stairs was constructed to give the access to deeper ice layers. (Figure 1)

These high vaults were regarded as the highest or one of the highest constructions in villages in the head of summers especially in central regions, the sun heats the Yakhchal when high, just the upper parts get warm and the lower levels of vaults remain cool.

3.2. Underground Yakhchal

Another kind of Yakhchal was built in north – central and also western part of Iran whose function was similar to vaulted Yakhchal but its physical appearance was different. Most part of this kind of Yakhchal body located underground its thick wall was made of brick and spall with hydraulic mortar like lime and sand cement and Sarooj³. [5]

Its roof was often of brick in the form of barrel vault or ribbed vault as figure 12 shows , after ice freezing in ponds , they pour ice into Yakhchal through a valve beneath arches every time ice was poured, they sprinkled water on it to make is homogenous. In this kind of Yakhchal, ice layers were not covered with straw because it was a cold climate and even in summer ice remained frozen summer time. Ice was delivered through the lower door. This door was connected to the around through stairs. (Figure3)

In western and north- western regions of Iran, the weather was cooler than desert so less vaulted Yakhchal can be seen there and using natural ice provided from shadowed foothills was common. Madam Dieulafoy wrote about Yakhchals in Tabriz: “returning from consulate, we passed by Yakhchal these constructions are meant to store ice in winters. People bring ice out in summers to sell. It is easy to provide ice with little labor. People fill pitfalls adjacent to high walls in winters water freezes during the night. In the morning, workers break ice into pieces and store them in underground for summer” [6].

3.3. Roofless Yakhchal

The third kind of Yakhchal was without Roof which we named it Roofless Yakhchal. It was built in Isfahan. Like other kinds of Yakhchal, it was used till 30-40 years ago. Its length was 4-5 meters and its height was 12 meters. In the North of it, people built a pool 5x5x12. As mentioned before, they provided ice during the night and at dawn. People transferred them into the pool.

As Charden pointed out like before, people poured ice into Yakhchal. First, they broke it into smaller pieces, and then they poured water in it to get homogenous. After that, they put wicker or straw on it and next they put another layer of ices. Therefore, a layer of straw or wicker was placed between two layers of ice, as a result, in summers during the sale, picking up the ice was easier than breaking the ice of the whole pool. Second, when they wanted to pick up a layer of ice, the wicker beneath, it was functioned as a non-conductor for the rest of ice in the pool. Putting straw and wicker between layers of ice was also common when using vaulted Yakhchal.

³ - A special mortar made of sand, clay, egg whites, lime, goat hair, and ashes in specific proportions, and was very resistant to water penetration.

When the sale ended, people covered the surface of ice with 1-2 meters of straw and gradually used it in hot weather. The capacity of this kind of Yakhchal in Isfahan was so great that some ice remained for the next year but there is no such Yakhchal anymore.

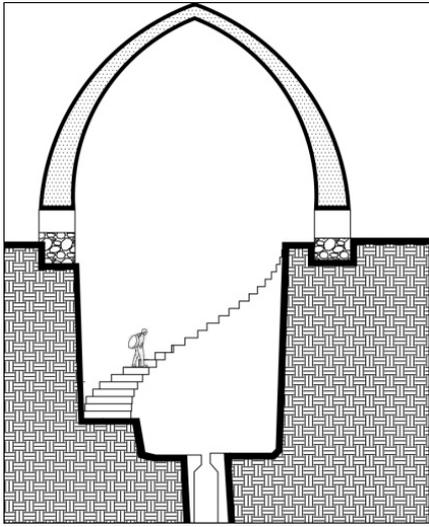


Fig. 1



Fig. 2

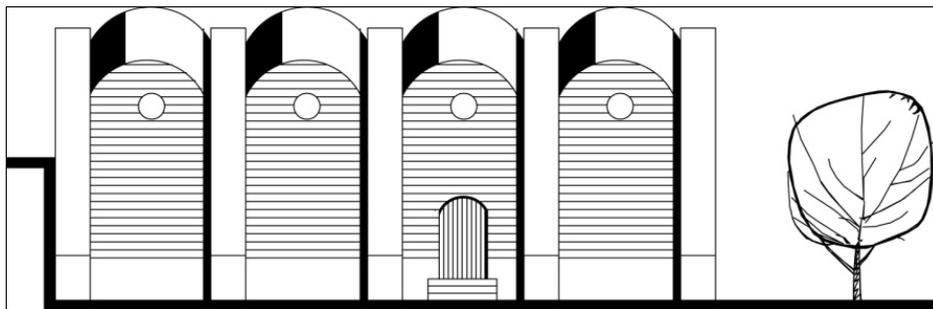


Fig. 3

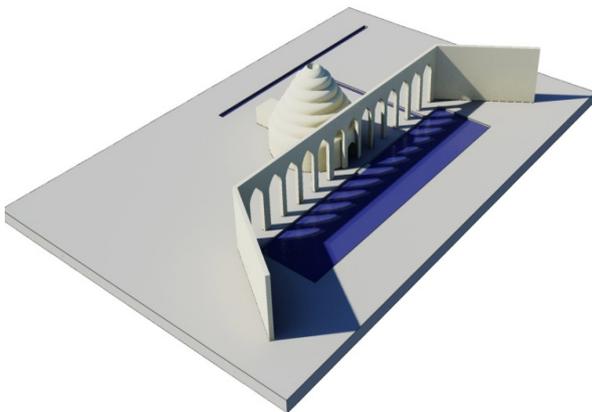


Fig. 4

4. Conclusion

Iran's traditional architecture is caused by the climate and conditions in which it has been grown and developed, so climate as the most effective factor has been affecting architectural element structures, like Yakhchal, which was built with climatic function counter with harsh climate. The Yakhchal is the most intelligent arrangement that proceeds of exploitation from massive walls and shadow, and at last it makes possible the preservation of ice in hot regions. This great Iranian phenomenon in architecture is as yet little known in the West and there is so much to be learnt from it and the building techniques which are integral with it. Not only is the building tradition itself still alive, but there is so much to be gained from the knowledge of a highly developed technology which makes such ingenious use of natural resources without the consumption of additional power[7]. we can also apply so many elements of this earliest phenomenon nowadays in some hot arid regions in which the accessibility of water is not sufficient or even the quality of cold water is not favorable enough. However there are a few vaults and underground Yakhchals in suburban areas in Iran unfortunately and unless positive action is taken these Yakhchals will be totally extinct so that nowadays, Inside of them are full of garbage and animals bodies. They stink so much that any researcher or explorer runs away from them.

5. References

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