# INTRODUCING THE MEANING OF SUSTAINABILITY IN CONSTRUCTION OF YAZD'S SARDABS (CELLARS)

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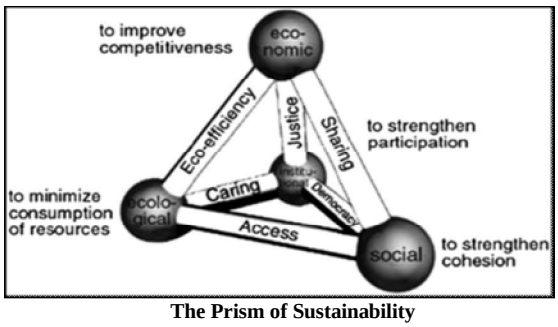
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**Problem Statement**: The idea of sustainability is one of the important concepts in today's modern world. In this concept, special attention has been paid to a comprehensive approach toward establishing a balanced connection between the three main elements of society, economy and environment. In some developing countries, efforts are focused on environmental and technologic aspects regardless of social and economical elements. Approach: This passage will try to survey the comprehensive prospective of old Iranians toward the meaning of sustainability in the construction of Yazd's Sardabs (cellars) and the space related to them. These buildings will be analysed in terms of social, economic and environmental elements. Result and Conclusion: Thus, criteria and provision will be extracted and deducted by surveying Yazd's Sardabs (cellars) which seem to have managed to create perfectly balanced connections between social and economic aspects of a sustainable architecture which can well be used in today's modern world.

**Key words** - Cellar, natural ventilation, society, sustainability, technology ,thermal comfort.

## I. INTRODUCTION

About half a century has passed since the first principles of sustainability emerged in societies around the world; this is while some developing countries show considerable delay in implementing these principles in their architecture and literature. Studies have been carried out upon how societies have approached the three main elements of sustainability i.e. Economy, Society and Environment. Some developing countries are facing various problems due to a lack of attention to these aspects. Iranian Societies, with an ancient civilization and a rich cultural heritage have never faced the same challenge twice. They have always worked hard to find the best possible solution to their cause. To clarify this, a study has been carried out on the "Sardabs" (Cellars) of Yazd and other interconnected spaces like "Payabs" and "Showadans". During hot season, ancient Iranians would seek refuge in Cellars and other surrounding underground spaces. Attempt has been made to study these spaces in terms of Economics, Society, Environment and the relations established between them in order to form a comprehensive approach toward a sustainable architecture.




**The Prism of Sustainability**

## II. THE MEANING OF THE TERM CELLAR

In the glossary of "Dehkhoda" and many other existing glossaries, "Sardab" refers to an underground space specifically designed to remain cool throughout the year, suitable for storing food and beverage; or a springhouse underground to keep coffins. In Oxford dictionary, Cellar and Crypt are the closest suggestions. Cellar refers to an underground room often used for storing things and Crypt is a room under the floor of a church used especially in the past as a place for burying people.

## III. INTRODUCING CELLARS AND LINKED AREAS

People from different regions have different interpretations of the word "Sardab" (cellar), in some cases different terms are used for the same concept. For the sake of this discussion, the dialect of Yazd has been used as reference for this word and all other related terms. At first glance, the words "Payab", "Sardab" (cellar) and "Zirzamin" (basement) appear to be the same, even people familiar with traditional architecture may get confused if they haven't lived in one of these places. There are slight differences between these terms which will be briefly explained later in this chapter.

### A. Payab

As water descended deeper into the ground, local inhabitants had to dig ever deeper to reach water. For that purpose, ancient Iranians used different methods, some of which included digging holes and "Payabs". The traditional architect would build stairs to move down step by step towards underground water. He

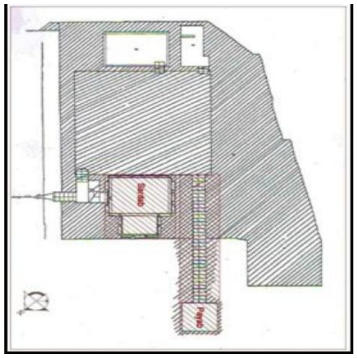
would build inclined ceilings to capture light inside the Payab. In many Iranian traditional houses, Payabs were located in the summer house with regard to local navigation and the path of "Ghanat" (aqueduct) water. For example in the interior area of the house of Gorji – One of the most treasured houses of Ghajar Era- Payab has been positioned in the summer house with regard to the path of Mahmoodabad Ghanat (aqueduct). Payabs were often private spaces, though in some places like mosques they were made public. In some villages on the sidelines of Yazd, the term "Pakaneh" was used to refer to a public place with access to water.

**B. Cellar**

In the traditional architecture of the driest regions of Iran, spaces have been made underground for different purposes. They were generally called "Basements".

Sardabs (Cellars) are basements situated near water. It should be said that the suffix of "ab" does not necessarily imply the presence of water in these places and can carry other meanings. For example, the word "Garmabe" consists of two parts, Garm and Abe. In this case Abe means building; so the word Sardab (Cellar) was used to refer to a cold building.

An important characteristic of a Cellar is its special affiliation with water. They would be built near Payabs and used their cold fresh air to provide a suitable living environment as well as a place to store food and beverage. In some cases, the traditional architect captured light inside the area by building the Cellar walls slightly higher than the ground floor; other techniques such as marbling the yard were used in Cellars which were built deeper underground.



**Basement Plan, the house of Rasoulian**

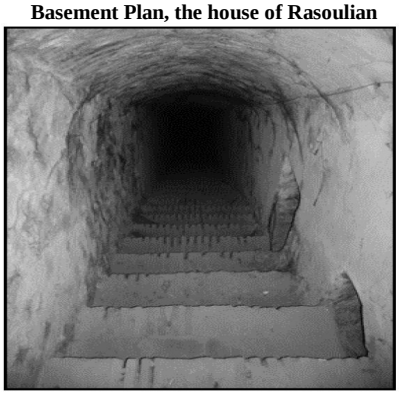


**Figure1: Payab, the house of Gorji**



**Figure2: Sardab, the house of Gorji**

**C. Showadan**

Figure 3 shows another underground space called "Showadan", which can be found in some old neighborhoods of Dezful and Shushtar. Showadan consists of rooms built about 6 to 7 meters underground. These rooms would include most of family needs during the hot season and staircases were built in the rooms, yard or the portico to provide an easy access.

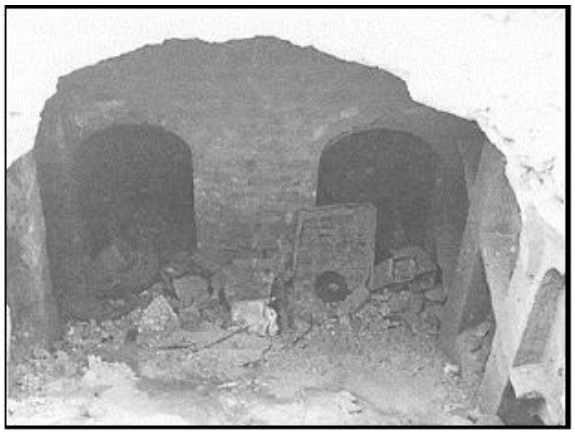


**Figure3: Showadan**

Due to the quality of soil in these regions, Showadans are merely spaces dug underground without the use of any construction material. In some cases, the walls would be coated in a protective layer. Many neighboring Showadans would be connected through a series of canals, which would result in a better ventilation of the area. Sometimes these canals would connect an entire neighborhood underground and ultimately lead to the "Dez" River. Showadan included many different parts, some of which include the stair case, the stage, Tals (a series of narrow horizontal underground canals connecting many neighboring Showadans), Seisara or Darizeh (valves about one meter thick used for light capture and vertical ventilation), Ket (Hallows in the ground).

## IV. SOCIAL RELATIONS IN CELLARS AND OTHER INTERCONNECTED SPACES

In the concept of sustainability, a delicate balance is to be established between the elements of society, economy and environment. The element of society is vital for various operational aspects of architecture. The fact that various household affairs took place in the interconnected spaces of cellars and Payabs, bears witness to their social acceptance. The status of cellers and Payabs in household routine

At the staircase which lead to the "Bonab" and payab food products were neatly placed for easy and comfortable access for all family members. During the hot season, fruit such as melon and water melon were placed on the lowest fore steps of the stair case close to water. Inside the Bonab, many shelves would be made in small spaces which would be used to store containers of oil, cheese and other daily products. A basket containing lam and beef would hang from the ceiling of the room. This shows that Payabs were not merely places to find water but had various functions due to their chill and moisture. Water in Payab would fill the Hoz (pool) for daily use and containers for drinking water. The flow of humid air along with the coolness of the Cellar offered a pleasant living environment in the extreme heat of the hot season in the province of Yazd. In summer mornings shadows of trees gave a good start to family life. As it became warmer through the day, family members would head for the "Talar". The burning heat of the afternoon didn't leave much of a choice but to seek refuge into the cellars for lunch and afternoon rest. People with an adequate experience of living in cellars agree that the place would sometimes get so cold which made it very hard to sleep without a blanket. After dark, people would spend their time in the yard where a pleasant breeze was blowing though the top windows of the cellars. Later at night, they would move up on the rooftops which had by then been sufficiently rinsed and ready for dinner and a peaceful night.



**Figure4: The connecting canal between Cellar and Payab**

### A. The effects of cellars on family ties

As mentioned above, cellars were places away from the extreme heat of the summer time where families would come together. Inevitably they would start talking about issues in their lives and exchange ideas and give each other comfort and fine strength and peace in the presence of their caring companions.

A "Korsy" would play the same role in winter time, were the pleasant heat served as a good reason for family gatherings. Such things enhanced family ties as the first building blocks of the society, which seem to be lacking in our modern life.
In Cellars, light was not as intense as it is outside, which makes it an ideal place to rest one's mind and soul following a day's hard work in the extreme heat of summer.

### B. Social Relations in Showadans

Showadans were often used during hot summer days. Life took place underground just as well as it did above. As it reached well beyond fifty degrees C in summer days of Dezful, it remained as cool as 22 to 25 degrees in Showadans. This made them ideal shelters against the burning heat of summer. The unique architecture in most Iranian dry cities manifests itself in the form of elements such as weathering, Tent, dens trees etc. Although the cities of Shushtar and Dezful were very much made up of dens neighborhoods and narrow allies so full of wind and shade, they enjoyed a god given gift which enabled local inhabitants of the region to create such a reliable and innovative architecture.

Thanks to this unique design, local inhabitants found enough shade and breeze to go by their lives during the day and then move down the cool Showadans during the peak of the summer heat. In some seasons rooftops provided a pleasant environment for the afternoon rest. Just like the province of Yazd, normal life was underway from rooftops to underground Showadans. An underground network of neighboring Showadans and easy access to the river bed, along with many other strategic defense mechanisms against perpetrators created an underground lifestyle in the old cities of Dezful and Shushtar. Some Showadans contained all the necessities of life; and people moved their social affairs underground. There, just like on the ground, house hold territories had been clearly marked; as if the "Tals" which linked neighboring Showadans also served as barriers between them. In some cases, Tals were partially covered with breaks in order to respect neighbor privacy while conditioning the atmosphere. Overall showadans were like living places and the Tals as allies and canals between them.

## V. ECONOMIC EFFICIENCY IN CREATING CELLARS

Just like the elements of society and environment, economic measures play a key role in the concept of sustainability. Implementing sustainability very much depends upon economic factors as well as social ones. If a project is designed based on the concept of sustainability, so as to minimize the need for non-renewable energy sources, but is not perceived as economically efficient, it will remain on papers and never find its way out to the society.

Throughout the city of Yazd, the ground is made of clay 2 meters deep, on which loading is not possible. Underneath it, there lays a very hard layer called "Chello" or "Kereshk", on which architects would choose to load the construction. Digging the ground to reach the Chello eliminates the cost of soil pretreatment. Also the space formed as a result of this pretreatment allows the architect to set out for an underground design. The removed soil would then be used in construction material. It would be turned into "Khesht" (adobe) right at the construction site. This adobe would be used to build walls and ceilings, hence eliminating the cost of material transportation. Bear in mind that these houses were completely environmentally friendly. And cause no harm to nature once they have been demolished. This soil was considered very suitable for agriculture as well. In the garden of "Dolat Abad", the garden soil, after several planting cycles would be used in constructions and the soil obtain from demolished houses would be used in the garden. As mentioned above, this cycle would never damage the environment in anyway. This is while modern buildings made of steel and concrete cause irreparable damages to the environment once demolished, not to mention all the environmental damages, resulting from the production process of these materials.



**Figure5: Adobe, the house of Gorgi**

As mentioned above, cold Payabs were used to store meat and fruit. This would save the energy required for the electronic devices. In the hot summer days of Yazd, callers provided a pleasant living environment without the need for electronic cooling devices that cost a considerable fortune to our modern lives. This natural cooling system used the energy of the earth and the flow of wind over water without the need for any non-renewable energy sources. Bear in mind that the same principles apply in winter time, were the ground floor of the house combined the energy of the sun with the heat of natural heaters to warm up the room.

## VI. ENVIRONMENTAL SOLUTIONS USED IN CELLARS AND OTHER INTERCONNECTED AREAS

In the concept of sustainability, along with the elements of society and economy, environmental measures should also be addressed. This aspect of sustainability mainly deals with practical solutions to create a better harmony with the environment. They include the use of plants and buildings to gain maximum shade, skewing and reforming buildings for minimum sunlight exposure and maximum wind, connecting the building onto the ground for an effective heat transfer, using shades over the windows facing the sun, creating a natural air-conditioning system etc. These solutions need to address social and economic measures to be accepted by the society. As mentioned above, in the concept of sustainability, a comprehensive approach is required toward establishing a delicate balance between social, economic and environmental aspects.

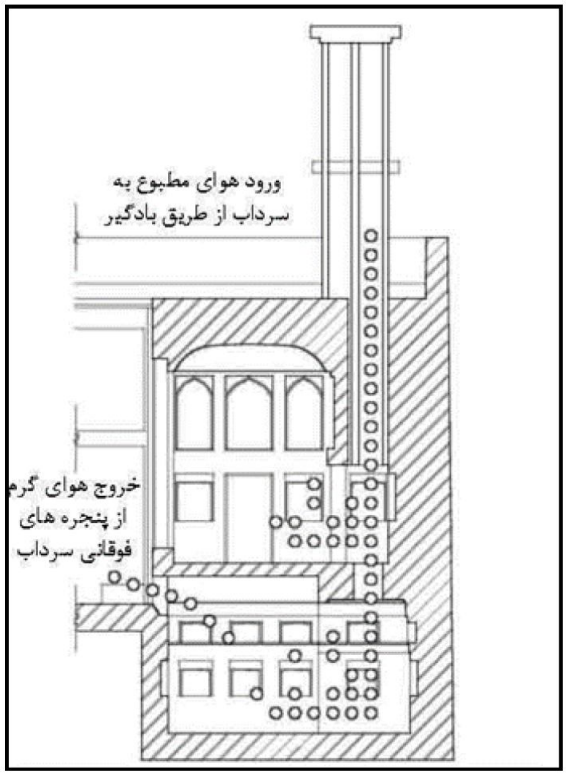
### A. Environmental solutions implemented in Cellars

Moving underground is hence a good way to establish a balanced temperature with the environment. Temperature in the Showadans of Dezful and Shushtar are about the average temperature throughout the year, i.e. 25 degrees C.

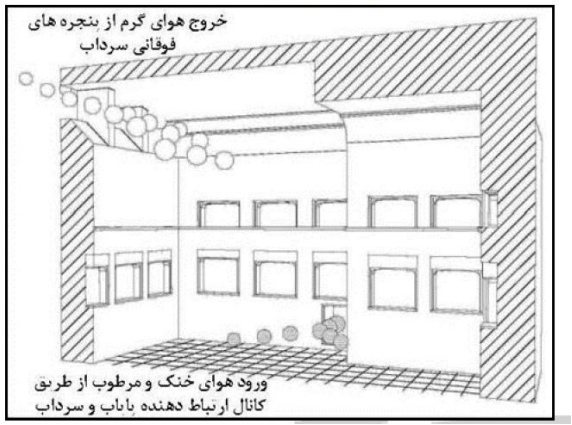
Positioned in depth less than 6 meters, conditions are quite different in Cellars and Payabs. Inside these places, temperature depends on outside temperature as well as the constant temperature of the ground in the average depth of the Cellar. Therefor it changes depending on temperature variations in different seasons. In spring and summer, Cellar temperature is ideal and constant, the effects of the ground's constant temperature on the Cellar is greater than that of the outside. In fall and winter, Cellar temperature falls, and thanks to the natural air conditioning, the effect of ground temperature becomes weaker than the temperature outside. (Mazarron, Canas, 2009)

In the cellars of Yazd, cooling was done through the process of surface evaporation by to the use of appropriate material such as bricks on the Cellar floor.

In the deserts of Yazd, the use of appropriate material in different parts of Cellars and Payabs was another way to curb the extreme heat of summer days. Because of their high thermal capacity, construction material would absorb most of the heat received during the day allowing the interior surface of the cellar to remain cool and last longer than the exterior ones.




**The mechanism of badgir (Wind Catchers) and Talar in Sardab (cellar)**




**The mechanism of the connecting canal between Cellar and Payab**

Cellars and other neighboring Payabs were often built on the summer house (the south east wing); so except the first few hours of the day they remained almost sunlight free. In the course of the day, as the sun moved behind the cellar wings and the buildings above, a shade would be casted on the ground preventing sunlight from reflecting on the surface material of the yard. The connecting canals between Cellars and Payabs allowed the cool and humid air to rise from the water surface of Payab into the Cellar gently forcing the hot air in the cellar out of the windows above. Cellars were often linked at a right angle with the Talar and the "Badgir" (Wind Catchers). The pleasant air captured by the badgir (Wind Catchers) would move through special valves into the cellar, it would then mix with the moisture in the room and the airflow of Payab to create thermal comfort. At night, pressure variation cause the badgir (Wind Catchers) to drain air rather than bowing it in; which would in turn remove the heat captured at the heart of the construction material in the course of the day.

**B. Environmental solutions implemented in showadan**

About showadan , in addition to above topics about cellars, "Tal" ,"Darizeh" and "Kat"'s rules ,are also mentioned in environmental solutions in this place.

"Tal" named as a series of narrow horizontal underground canals connecting many neighboring showadans. This canal in addition to connecting showadan's to each other, caused air's flow. Sometimes, these Tals, Arrenge connecting between some neighbour's showadan and with the last unit next to the river, end to river's border. From "Kat", fresh air next to the river's border get into Tals and transfer to the showadan."Darizeh", valves about one meter thick used for light capture and vertical ventilation. This canal connecting house's different places to showadan and cause air's fresh flow from showadan to house's places. Also some Darizeh's were caved to yard addition to prepare showadan's light. with aboarding earth, prepare essential empty space. in some sample's,Dazireh 's hatches are connected to the alleys and pathways even roofs, in this way the air always flowing.

In Tal's edges, tal and without glaze mud pitchers called –"Habbane"-, inside is full of water, were put in air's path flow. air's flow after striking to Habbane's wet edges, become more fresh and cause more elegance in showadan's air. The water inside Habbane's which keeping into Tals; because of proximity to air's flow is fresh and drinkable enough. Even though this fresh canals are good place for keeping decay nutrition. This give to understand that unlike desert citys or edge of Iran's desert that often include natural icebox; Dezful and shushtar's old inhabitants were accessed always to cool water of the river and water inside Habbane's and in this case there is no need to build icebox and reservoir. Imam shushtari was written in khuzestan's historical geographic book: Showadan's "kharshotor" and chilly home have stands which include some air conditioner and hatches with getting cold by thorn's herbs and

from the best natural devices's place for getting cold, pouring water to thorn to wind's flow among wet and watery thorns, become cold the cool home's place.

## CONCLUSION

In the concept of sustainability, a comprehensive approach is required toward the three main elements of economy, society and environment. Ancient Iranians had mastered this approach in their makings of Cellars and Payabs in such a way that these measures have not only been carefully addressed, but they are utterly inseparable. They have done so through different techniques such as the accurate positioning of the construction on the ground to use its constant temperature, using construction material with high thermal capacity to minimize heat transfer inside the Cellar, using appropriate material such as bricks on the ground to provide moisture in the air, accurate alignment of Cellars and Payabs in the summerhouse, drawing cold humid air from the water surface inside the Payab inside the Cellars while pushing out hot air from the top windows and using Talar and badgir for their give and suction functions in an effective air conditioning system. These solutions dealt with various household affairs had been accepted by the society. These measures served to enhance family ties in a pleasant environment away from the extreme heat of the sun throughout the hot season. These solutions were also based upon clear construction principles in which a firm connection with the ground was an absolute necessity. With the soil obtained from digging, construction material would be made at the construction site eliminating the cost of material transportation. These materials were completely environmentally friendly as they were extracted from the ground, and caused no harm to the environment even after demolishing of the building. Cellars and Payabs offered a suitable living environment in the extreme heat of the hot season without the use of any non-renewable energy sources. In today's modern architecture, such solutions can be implemented with a much higher degree of accuracy; and with appropriate economic measures in mind, they can be embraced by the society as whole.

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