Studying Local Standards of Masonry Structure of Traditional Baazars in Iranian Cultural Heritage

[1]SHAHRAM NASSEHZADEH TABRIZ, [2]FARIBIRZ MAHDAVI TABATABAEI FARD, [3]VAFA ASL ASADI, [4]AHADOLLAH A'ZAMI, [5]ZEYNAB NIYAZI
Department of Architecture
[1]Islamic Azad University-Miyaneh Branch, [2],[3],[5]Islamic Azad University-Tabriz Branch
[4]Islamic Azad University-International Jolfa Branch
IRAN
[1]Sh_nassehzadeh@m-iau.ac.ir, [2] sabat_arc@yahoo.com, [3]asadi.vafa@gmail.com, [4]azami@iauj.ac.ir, [5]irsesta@yahoo.com

Abstract: - Baazar (Iranian traditional market), as the main pathway and economical relation artery in hot and dry area of Iran has created a surrounded space with its continuous cover and it catches the light through holes and vents and as well as being in harmony with spiritual and social needs of people, for its climatic and ecological design it has structural connection with adjacent buildings and expresses a united place in the presence of diversity, abundance and a developed hierarchy regardless of diversity of functions. The high roof of these Baazars were covered with clay and straw and were constructed as binding arches, cradle with number of angles or arches on stool gable. In addition to their constructing role, arches of Baazar acted as heat capacitor and they also hindered unavoidable noises of Baazar spaces for their solidarity and kind and form of used masonry material. On the other hand, width passage or pathway was of special importance as the main element which determined the importance of a space and caused harmony with human metrics of passersby. This article discusses the local standards of Iranian cultural heritage through comparative studies of design scales in functional spaces of traditional Baazars of Kashan, Isfahan, Shiraz and Kerman approaching masonry materials and climatic conditions.

Key-Words: - Climatic Baazar, Masonry Structure, Cultural Heritage, Domestic Architecture

1 Introduction

Old Iranian cities are mostly trading cities. Therefore, Baazar is not only the economical and trading center of the city, but also it is the center of social, cultural and religious activities and as the organizing spine of architectural elements affects the group activities of the city. None of the traditional architectural works have the functional and body diversity as Baazar. Therefore, in spite of being old Baazars are still lively. Baazar was not designed as a complete plan in Iran and it was very flexible in the case of spatial and functional usages. Three main functions are on the shoulders of Baazar: to preserve and expand the economy of city, to grow and enhance the social-cultural relations of people and to strengthen the religious and moral beliefs. The secret of Baazar's sustainability can be found in its diverse functions of spatial architectural values and its structural strength. "The built space of Old Iranian Baazars are rich from artistic and technical point of view and they are mysterious, adaptable, deterrent and stuffy as well [1]."

The eight thousand year history of Iran in making the settled residential complexes has provided the ground for a different building system, which is based on available stuff of the area. The cultural-social stability of societies from one hand and the limited relation and administrational power of local stuff of each area from the other hand has led to sustainability and continuity process of the building in traditional societies. The mater and student training system in the old societies gave a practical understanding of the structural behaviour of the building to the architectures and it guaranteed the strength especially in traditional Baazars of the central plateau. Tradition, here, refers to dynamic interaction on the basis of culture and local atmosphere of the society and not the old and old-fashioned process. Even though Baazar is the trading centre and the heart of social life of the city and has the same function in different cities of Iran, it is seen that there are some difference in the Baazar of different areas regarding the body.

Some different kinds of Baazars like periodic, permanent Baazars and some, which were built beside the passing places were roofed, therefore people would be safe against the strong heat and cold in summer and winter. The cover of some Baazar in their simplest form was of flat wood or straw. Use of wood led mostly to making flat roof while use of brick and plaster led to building arched roof due to impossibility of making flat roofs of these in big entrances. According to a seal found in Shush showing a cereal silo, the history of

using arched roof in Iran dates back to the fourth century B.C. [2]. To cover the big entrances such as Charsou and Timcheh, the domes and Karbandis were used and the big entrances were simply covered with "vault rib" and created unique structures regarding the beauty. The Kar bandi was a method having lots of capability for diversity and beauty of the building cover. The roof of the Baazars were covered by plaster and straw like other buildings and the roof of Timchehs and some important and valuable places such a Jameh Mosque and schools were covered by brick and some strong mortars. In some case the roof of some buildings were used, for example dyers can be mentioned who dried their products on the roof of the Baazars.

2 Body Elements of Baazar

The functional expansion of Baazar is mixed with the diversity of its body spaces. The leaner blocks of Baazar are formed orderly due to the duplication of structural units or they are specified by the residence of different working classes and are separated from each other by the spatial processes. In addition to the main block of Baazar and the shops on both side of it, the sub blocks and the shops on their sides and in detailed scale the Sara, Karavansera, Tim and Timchehs do economical activities in bigger scales. The social, cultural and religious activities are performed in schools, mosques and the squares. The above elements join the spine of the Baazar and create a general and multifunctional complex [3]. The Gheisariyeh, block in a bigger scale, is formed in relation with trading valuable goods and Charsugh is formed in the intersecting place of two blocks. The Baazar block ends in the Jameh mosque (great mosque) of the city.

3 Selecting the Forming Building of Baazar

3.1 Region and selecting the structural system of Baazar

The first stage of designing a building is selecting among the choices for skeleton of the building based on the project condition. Iran is the land of diversity of regions and the regional characteristics and the local masonry of each region requires using a special structural system. Like other architectural buildings, Baazar is also affected by this feature. The un-roofed Baazar in the moderate and damp region of Khazar sea borders is as strong and as effective as the building with wood and straw roofs of Persian Gulf border and the arched Baazars in vault and Vault rib shape in cold mountainous area and plains and mountain foot of Iran plateau.

The vault and Vault rib system of Baazar have a high marquee with big entrances (Isfahan, Yazd, Shiraz, Kerman, Kashan, Tehran Baazars, etc.) as in Isfahan the width of the entrances are between 4.5 to 5 m and the ratio of height to width is 1.5 times and the opening of the building is balanced [4]. However, in mountainous regions the entrances and height are decreased and the openings are minimized to avoid waste of heat of the environment (Tabriz, Hamadan and Khoy Baazars) [5]. Therefore the structural system and scale of Baazar block is selected based on the regional condition and the local masonry to fulfill the spatial and architectural values (see figure 1).

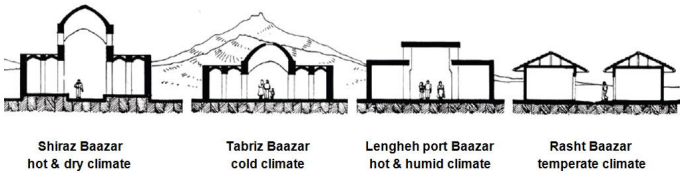

Fig.1: Baazar structure in four climates of Iran

3.2 Structural system in harmony with the Baazar economy

The value of goods and spaces of the Baazar determines the kind of building, its dimension and decoration. Once the valuable works are placed in Baazar block, we encounter valuable spaces, bigger entrances and higher marquees together with more beautiful structure in the roof (kar bandi) and more decorations and entrance and exit doors in the Baazar block. Such a block is called Gheysariyeh (Gheysariyeh of Isfahan Baazar and Gheysariyeh of Ibramin Khan in Kerman) (see figure2). In case of common goods the height and decorations are decreased, the controlling doors are omitted, and Baazar functions as a city passage (sub blocks of Baazar in Isfahan, Shiraz and Tabriz).

Whenever the block of the Baazar reaches to a valuable space (such as mosque, school and Karavansera) the structure or the decoration of the roofs changes suddenly and a different space suitable for the new function is created.

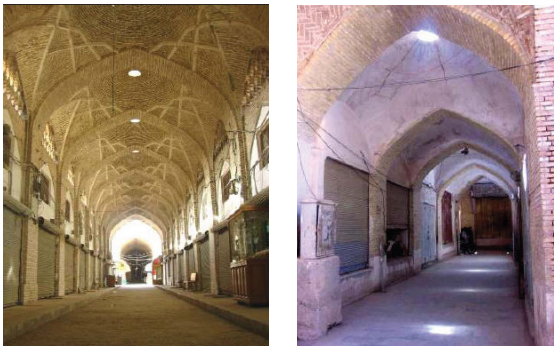

Fig.2: Gheysariyeh of Ibramin Khan in Kerman (left) Shoemakers row in Kerman Baazar (right)

On top of the block of the Baazar for the less valuable good selling, truss marquee of wood is settled and in the un-roofed spaces of Baazar the routine and cheap goods are sold (Ghadamghah block of Baazar of Kerman, Poultry Baazar of Shiraz). Therefore, the kind and scale of the structure, indicates the importance of the activity done in that block.

4 Arched Structures in Traditional Architecture of Iran

Due to the abundance and excellence of suitable soil in central plateau of Iran, non-resistance of soil masonry (mud and brick) against tensional powers and less access to suitable tensional masonry (soft building woods), the arched brick structures based on the transmit of the only pressure powers occupy the most space in the formation of the architecture of this area [5]. In arched-pressure structures formed by brick and adobe, the plaster mortar is used as the natural expanding mortar and at the time of setting up acts as stabilizer by putting pressure on the arch masonry. To control the arch thrust of the base of the arches different methods are used in traditional architecture: a) weighing the arch bearing, b) use of restraining wooden elastics, c) Use of backings (backings) and d) the high thickness of arch base pillars [6].

The arches (Chefd) with circle shape are not used in Iranian architecture. if the brick arches are constructed in such a way, they would break and fall. To avoid the break of form, when there was the probability of breaking toward outside, the half-circle would be brought inside and when it was possible to break inside the half-circle would be pulled toward outside. This method was the base of formation of the traditional arches [7].

4.1 Types of Arched Structures in Iranian Architecture (Vaults and Domes)

Different arched-pressure structures are formed in Iran's architecture due to the expansion and combination of the arches.

Ahang vault or barrel vault is formed by the expansion of an arched structure in line with the vertical axis to the arch plate. The transmit of the forces in this system is from vault to the pillars and then to the earth. Therefore, the pillars under the vault are dense and thick and it is difficult to make an opening in them. The thrust resistance in the direction of arched expansion (longitude) is provided by the internal resistance of the vault and the equivalent underlying wall.

Chaharbakhsh vault or intersecting vault is formed by the vertical intersection of two Ahang vaults and provides the capability of covering square spaces without limit in making openings in both sides but the limit of making opening in line with the Ahang vaults is still present.

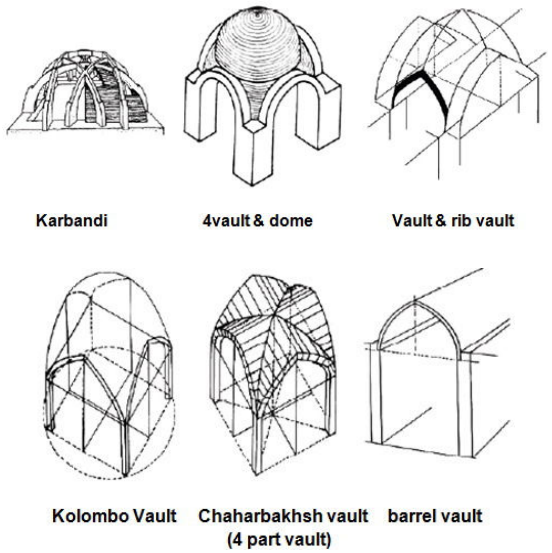

Fig.3: Arched structures in Iranian masonry architecture

Kolombo vault which is built on four walls and is used in seismic areas. In this kind of vault, the orthogonal walls enhance the stability of building against thrust powers in two sides by their internal resistance. In practice by the gradual slope of the masonry bond the vertical side of the vault is formed and covers the square space. The possibility of making opening is very limited in this kind of vault.

Vault and Vault rib is formed based on the bearing arched vault ribs on the pillars and the vaults filling the distances between vault ribs. The vaults are made is the form of Ahang, Khancheh Poush and Kajaveh. In this system, the spatial opening is not possible in both vertical and congruent sides to the Vault rib. This building system would be explained in detail in other chapters.

Chahartaghi is formed by four bearing arches on four pillars on a square space and is completely open from four sides and ends in dome by making corners. In such a system, the resistance against thrust is provided by thickening the pillars.

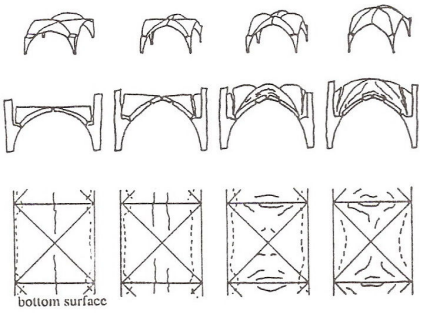

Fig.4: Different types of Chahartaghi (4 vault) and their crack because of length increasing

Dome shape vaults are formed by the circulation of an arch round a vertical axis to its opening. Considering the load transmit they act like arched structures. Therefore, they need to be strong in the stem of the dome to bear and transmit the thrust powers to the corners and underlying pillars. The domes are divided into Nari (lancet arch), oval (Mazeh in arch) and Rok types in making which radiant vault ribs (cracks) can be used.

Karbandi and Rasmibandi is constructed based on the bearing of vault berm (vault rib) and the in-between cover of them by thinner covering vaults. In this system, the bearing vault ribs cross each other before they reach to the center of the dome and create a junction pattern in the space which is considerable from atheistic and meaning point of view in the architecture.

It should be mentioned that the method of making masonry bond, dimension and the good quality of masonry are effective in the strength of the building which are not taken into consideration in this article [8].

4.2 Vault and Vault Rib Construction in Baazar Block

Because it is required to move in the blocks of Baazar and expandable arch construction must be used in the length axis. In addition, in order to have an access to the shops and lateral spaces repeated pattern of openings must be performed on the walls of the block. This characteristic cannot be made possible using a simple vault construction, because it transmits its force to the bearing wall and has lots of limitations concerning making expansion along the wall. Therefore, some parts of the construct are regularly reinforced bearing the weight of the ceiling so that the possibility of the opening in other parts could be achieved. The constructs used in Baazar blocks are composed of two parts: a) equal arch vault rib and b) vault and mesh covering (See figure 5).

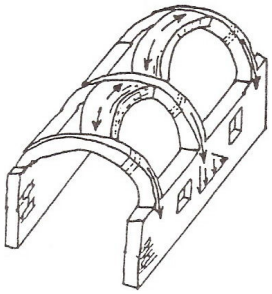

Fig.5: Vault and vault rib structural system, structural solution to transform force concentration away from openings by arches

In constructing vault ribs, steep arches (square or having three parts) are used to provide an efficient bearing of the arch as well as reducing thrust forces. While usual arches are used in vaults and meshes, which are two sided and having shorter height [9]. The ceiling load is transmitted through vaults to the Vault ribs and finally to the ground (See figure 6).

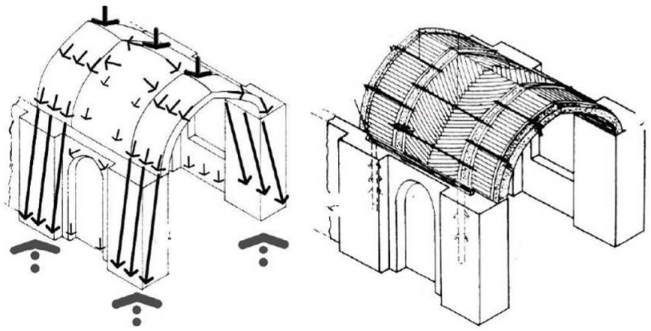

Fig.6: Transmitting forces in vaults and vault ribs (left) Construction of vault and vault rib in Baazar (right)

Vault rib as a pressure rigid frame resists against horizontal forces along its length using its inner resistance. The lateral shop construct also reinforces this resistance as a backing. The back and front vaults of each Vault rib act as connecting and transmitting the horizontal forces perpendicular to the length access of the Vault ribs. Similarly the unit constructs are connected to each other in bearing the horizontal forces. The first and the last Vault ribs are also connected to the lateral Vault ribs with some restraining ropes so the construct resistance against horizontal lateral forces such as earthquake and storm is reinforced. Balance, sustainability, resistance, efficiency, economical factors and the beauty of the construct are defined as determining characteristics [9]. Therefore, the bearing construct can be considered as one of the efficient constructs of Iran architecture.

5 Spatial values on the basis of construct and construct proportions in Baazar body

Baazar is a regular set of spaces, which has been capable to maintain its integrity despite the connection of several and different body elements. Although there are many differences along these roofed ways, the integrity and coordination of the whole space is obvious along the way because a construct unit in the linear organization of the whole way is repeated. The square shape of Vault rib and vault construction units and use of symmetrical axis to organize the shops and related elements to Baazar has created an orderly space together with movement and spatial hierarchy in the Baazar. All connections are located in the span of two bearing Vault ribs. The first lateral sheets located in the passerby part of the Baazar, indicate a special order created by the repetition of equal shops along the passageway. These shops acquire an independent identity by their walls, bases and special coverings.

Repetition of the construction unit along the Baazar route and the rhyme of the lateral shops, openings and use of light rhythm in Baazar space have led to spatial tension and invitation of the user to move through the Baazar route. In fact, the complex of Baazar can be introduced as a combination of moving in the blocks and staying in the junctions and adjacent elements. The movement and guiding the people in the space are considered as the main factors showing the aliveness of the Baazar.

Due to the similarity of the construction and lateral elements of the Baazar block, whenever a special building or connection is made along the route, the architect makes some changes in the type of vault cover, dimension of the building and decorations with his understanding of the construction and his artistic talent to prevent the embarrassment of the user. When a building (like Timcheh, Sara, School, etc.) other than lateral shops is connected to the Baazar block vault covering relevant to the opening of the building changes. For example, the vault and the mesh turn to a Kar-bandi which contains higher decorative and conceptual characteristics. The wall which is connected to the construction of Baazar block assures a new space when it retreats from the route length creating a suitable area. The decorations of this wall are different from the walls of Baazar block. The construction unit, mentioned above, can be a joint between two separate technical blocks which are placed in one alignment. In some cases, whenever the space of two technical blocks is separated, some construction units having no ceilings are used (Kerman Baazar) in which the difference in light is the characteristic spatial separation. Once two Baazar blocks hit each other perpendicularly a space with higher scale and more detailed decorations is shaped which is called Chaharsugh and can be distinguished from outside Baazar (Kerman Chaharsugh Baazar) (See figure 7).

In Kerman's Ganjali Khan Baazar and in the Baazar surrounding the primary space of Naghshe Jahan Square in Isfahan the Baazar block facing the square is widened and it has created a unique spatial quality owing to omitting a set of lateral shops and the separating plate relevant to it under the vault construct. Because of using bearing Vault rib in the construct the pressure forces of the wall construct is first transmitted to Vault ribs and through them it is finally transmitted to the ground. In such a method the load which is placed on two lateral plates of the construct – span between two Vault ribs – is removed and the wall turns into a separating non-construct shield.

As a result the wall can be removed and the Baazar block can be widened facing the square. Widening the Baazar space, which faces the square, is an innovation toward making the two heterogeneous spaces of Baazar block and the square adjacent which reinforces the forces available between these two spaces.

Fig.7: Spatial integrity in Vakil Baazar, Shiraz city

Considering the transmission of pressure forces in kar bandi ceilings inside the bearing vaults berms and the possibility that some parts of the ceiling can be opened, changing the scale of the construct in Chaharsughs and widening special louvers forms a space different from Baazar block. And while having qualitative and dimensional differences it has preserved its coordination with other parts of the space.

5.1 Types of Arched Structures in Iranian Architecture (Vaults and Domes)

Natural light has a special place in Iranian architecture and they know it as incarnate of the spirituality. In architectural space of Iran the light and darkness hierarchy is used in directing and guiding from one space to another. Due to the kind of force transmit, the opening in pressure constructions have special limits. If the opening is placed on the way of force transmit, the construction would fall. Therefore, at the time of need for ventilation and light in the space, the construction shall be divided to bearing Vault rib and covering parts. In such a way, in the covering and non-bearing parts and by considering the geometry of the vault, some openings can be devised. Making opening in Baazar construction can be done in for ways:

- In the spaces where the ceiling of the Baazar is high, in the span of lateral shop ceilings and vault and Vault rib construction of the Baazar blocks, some openings are devised for catching light and ventilation of the space (Vakil Baazar of Shiraz and Mesgaran of Isfahan).
- In Chaharsughs and kar bandi ceilings the openings can b made to catch the light using covering space between driving bearing Vault ribs (Chaharsugh of Kerman, Timcheh of Aminoddoleh, Kashan).
- In the vaults of the Baazar blocks a pressure circle is devised by brick in the center of the mesh vault which provides the light of the block with its special and

different rhythm during the day (Vakil Baazar of Shiraz, Isfahan Baazar, Kerman Baazar) (See figure 8).

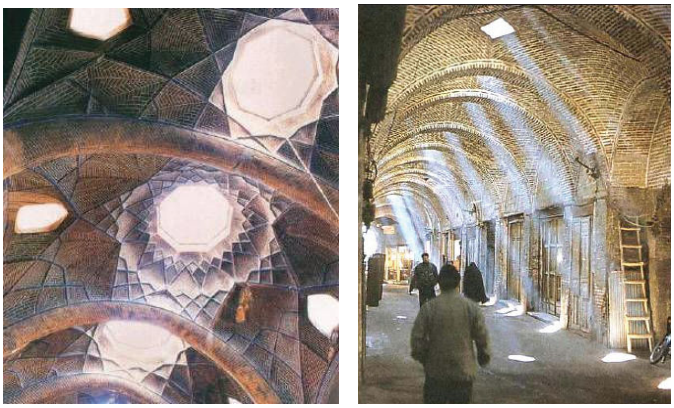

Fig.8: Ceiling openings in Kashan Baazar (left)
Daylight in Raasteh (series of shops) Baazar (right)

- Omission of the ceiling or one of the lateral walls in the intersection place of two heterogeneous spaces in Baazar (Ganjali Khan and Ibrahim Baazars of Kerman).

5.2 Body Expansion of Baazar and Constructional Module Proliferation

The Baazar of Iran cities, would never designed completely beforehand. By the expansion of city, the Baazar would be expanded accordingly. Baazar is like an alive texture in the whole city which moves has a slow movement and follows an organic order. This expansion occurs first in line with the main block (the most important city passageway) and after being limited to the city enclosure is shaped in another direction intersecting the main block (Kerman and Shiraz Baazar). If the linear expansion of the Baazar were limited, this would happen as parallel blocks to the main block (Tabriz and Ghazvin Baazars) [2]. Form the other hand the necessary protective spaces of the Baazar would be provided by the dorsal space layers. Therefore, the Baazar would have an expanding linear growth by the proliferation of constructional module and an inner growth from inside to outside.

7 Conclusion

The structure and construction of Baazar is formed regarding the regional and economical conditions and local masonry and by the correct understanding of localized construction, the Iranian architecture has been able to use the construction potentials for providing its architectural values. As one of the most dynamic city constructions, Baazar forms the spine of the cities. The vault and Vault rib construction, which is used in the Baazar blocks of the central Iran, is in complete accordance with spatial-body values due to the correct understanding of Iranian architecture of its potentials and limits. The similar and heterogeneous spaces of the Baazar with their clarity and general integrity, spatial mobility and tension, use of the construction capacity to make opening and provide the arms and use of the constructional unit (module) to specify the borders and expansion of the Baazar space, are some considerable points in the coordination of the construct and architecture in the Baazars of Iran. This complete coordination between architecture and the composing construct in Iranian Baazar, which is the result of interaction between spatial – body values and the potentials and techniques of the construct, has acquired a dynamic and sustainable composition in the Iranian culture and identity and has achieved efficient construct and architecture regarding the available facilities. The return movement between selection of construct system and its design, providing the structural needs and spatial-virtual values are significantly considered in Iranian Baazars. Therefore, by recognizing the arched construction systems and the features of new masonry together with having knowledge of spatial values and architectural goals, which gives identity to the constructed environment, the integrity and construct interaction and architecture, can be used for the efficiency of architecture made by human.

References:

[1] Falamaki, M., *Rehabilitation of Old Buildings and Cities of Iran,* Tehran University Publications, 2002.
[2] Soltanzadeh, H., *Iranian Baazars,* Iranian Cultural Heritage Organization Publications, 2002.
[3] Pirnia, M., *Introduction to the Islamic Architecture of Iran,* Iranian University of Science & Technology Publications: Tehran 1996.
[4] Ahari, Z., *Ilamid Isfahan Style in Urban Design,* Tehran University Publications, 2002.
[5] Ghobadian, V., *Climatic Analysis of the Traditional Iranian Buildings,* Tehran University Publications, 2006.
[6] Moradi, A., *Twelve Lessons on Restoration,* Centre for Architectural & Urban Studies and Restoration Publications, 1996.
[7] Kiani, M., *Iran Architecture of Islamic Times,* Cultural Research Organization Publications, 2005.
[8] Zomorshidi, H., *Vault and Arch in Iranian Architecture*, Keyhan Publication, 1995.
[9] Zomorshidi, H., *Architecture-Building Performance with Masonry Materials*, Zomorrod Publication, 1996.