Spatial and Structural Features of Domes in Iranian Architecture: Soltanieh Dome in Zanjan, Iran.

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Abstract

One of the most salient and important elements in Iranian architecture is the roof cover; the dome. The process of dome construction in Iran dates back to the periods before Islam and has experienced considerable advancements during the Islamic periods. Geometry, mathematics and the creation of new tools have had a direct impact on the architecture of domes and its advancement. This paper presents the construction of domes in Iranian architecture from a historical perspective, and its position in Islamic architecture. It classifies different types of domes, and then closely examines the Soltanieh Dome located near Zanjan. The Soltanieh building was constructed during 675-685 AH and is located about 2000 meters above the sea level. The building design is based on the number 8. What is seen in this building like other Islamic buildings is the focus of the octagon in the center of the building. The burden of vertical movement is on the minarets. There are two types of minarets; a hidden minaret located inside the building skeleton and another minaret in the form of finial in the upper part. In the Soltanieh building, the horizontal movement is at four levels, which are related by the vertical components. The paper shows the decline and advancement of the impact of mathematics and geometry on Iranian architecture

Keywords: Historical trends, Structural and spatial features, Iranian architecture, Soltanieh dome.

Introduction

Different human cultures have different built and unbuilt manifestations by which they identify themselves. These cultural manifestations stem from the spirit governing people's thoughts and worldviews, and one can find out the worldview of any nation by examining the cultural manifestations of that nation. Deep concepts lie in the manifestations of any culture. Art and literature may be the most important cultural manifestations of any nation and architecture is regarded as the most prominent built manifestation. It is evident that architecture of any culture manifests the esoteric concepts (Kashani, 1987).

On the other hand, artists always seek to convey a message by creating artworks. Even when an artist creates an artwork for himself, he crystallizes a concept that remains like a soul in the work. Architectural works have hidden meanings related to the artist who has tried to convey them explicitly or implicitly by using its language. These employ the elements of a building and its decorations.

Thus, the elements of a building must be regarded as the location, which embodies the meanings. In the worldview of the traditional societies, architecture is regarded as a miniaturized world and its function is beyond a mere building. Reflections on sacred architecture show that the position of sacred architecture in the traditional societies is quite symbolic and visualizes a specific meaning. Similarly, in the philosophy of sacred architecture, a building is regarded as the manifestation of meaning (Zabihian,2008).

Dome as a roof

Dome, while not a ritual requirement like the *mihrab*, does possess implication within the mosque as a symbolic representation of the vault of heaven. The interior decoration of a dome often emphasizes this symbolism, using intricate geometric, stellate, or vegetal motifs to create breathtaking patterns meant to awe and inspire. Domes have a long architectural lineage that extends back into pre-history. However, the symbolism associated with domes and governmental traditions have developed over time.

Dome usually refers to forms that are hemispherical, and in the geometrical definition, dome is the geometric location of points created by rotation of a certain Chafd around a vertical axis. On the other hand, it is an architectural element which is a symbolisim of creation of decoration and variety of form.

Dome is an architectural element that resembles the hollow. The precise definition has been a matter of controversy. There are also a wide variety of forms and specialized terms to describe them. A dome can rest upon barrel, and can be supported by columns or piers that transition to the dome through pendentives. Domes have a long architectural lineage that extend back into prehistory and they have been constructed from mud, snow, stone, wood, brick, concrete, metal, glass, and plastic over the centuries.

Domes have been found from early Mesopotamia. They are found in Persian, Hellenistic, Roman, and Chinese architecture in the Ancient world, as well as among a number of contemporary ethnic building traditions. Dome structures were popular in Byzantine and medieval Islamic architecture, and there are numerous examples from Western Europe in the middle Ages. Advancements in mathematics, materials, and production techniques since that time have resulted in new dome types. The domes of the modern world can be found over religious buildings, legislative chambers, sports stadiums, and a variety of functional structures.

In Iran before the modern period, arches and domes were created due to climatic and structural needs. Dome is one of the main elements of architecture used sometimes for covering different spaces and sometimes as a sign of strength and power of governments. Dome has a long background in Iran. Shortage of such woods as teak, cedar, or pine has made circular coverage prevalent in the hot and dry regions of Iran and it has been substituted for flat coverage particularly in the large spans. Arches and domes were built using local materials such as brick and mud brick because of easy access to the local materials and technology, which accelerated the construction operation and harmonized a building with its surrounding nature (Khodadadi, 2011).

Intellectual decline or advancement has had a direct impact on art and architecture. Advancement of science and geometry, mathematical tools, and construction techniques have made architectural changes over time. It is evident that creating a dome like the Dome of Sheikh Lotfollah Mosque or Shah Mosque that are among the greatest masterpieces of the traditional art and architecture indicate that such a rational life has existed at that time (Nasr,1996). Geometrical spaces, very

precise mathematical ratios, and certain lines related to precise mathematical principles were tools by which the Islamic architectural spaces and their external surfaces were formed (Nasr, 1996).

Fig. 1: Soltanieh Dome, symbol of the Iranian creativity
(Source: soltanieh-wikipedia 2018)

The dome that covers a large span was firstly used in the Parthian architecture style. This style of architecture appeared after Alexander the Great's conquest of the Achaemenid Empire in the 3rd century, and historically includes the Sassanid, Parthian, and post Islamic eras, up to the 9-10th centuries. In fact, Rasouli argues (2007) that dome was a gift that Parthian architecture provided for the world. Dome raised many issues and has been observed in different forms in Iranian architecture. Domes built in the Sasanid era were mainly circular and oval. Later, domes were built in other forms too; short saucer domes that require thick walls or counters to bear a heavy load or high domes placed with long cylindrical stems were prevalent in the Timurid era. Bulbous domes were often not accepted by the architects due to some structural problems and lack of sense of calmness. From the 12th century onward, another form of domes became prevalent and was used in building circular or octagonal buildings like tomb towers (Pope, 2009). Some of these buildings have remained up to present. In this context, the objective of this paper is to study the spatial and structural features of domes across the historical periods of Iranian architecture and specifically the Soltanieh Dome in Zanjan.

The Soltaniyeh dome: A review of literature

The Soltaniyeh dome is particularly emblematic of the Il-Khanid period architecture in Iran. Medieval Persian architecture is best described as an amalgam of several precedents and styles, which were adopted and combined given the strategic economic and geographic location of Iran.

One of the oldest elements influencing Medieval Persian architecture (and what would come to be defined as traditional Persian architecture by the time of the Safavid dynasty in the 15th century) is Sassanian architecture. Developed during the Sassanid Empire, this architectural style was defined by large imperial porches, as well as large vaulted ceilings, which can be seen prominently in the ruins of Ctesiphon, in modern day Iraq. The use of brick as both structural and decorative elements was pioneered in the Sassanid Empire. These elements were quickly adopted into early-Islamic architecture. Brought from the Arabian peninsula in the mid 7th century, early-Islamic style prototyped hypostyle mosque architecture (large flat-roofed prayer halls supported with a multitude of columns). This open program was

quite flexible as there were few religious restrictions on mosque design (e.g. strategic orientation toward Mecca). By the 11th century, elements of Sassanian architecture prominently appeared in mosque design in Iran and elsewhere in the Islamic world. The Jameh Mosque of Isfahan (constructed and rebuilt in several stages) reveals the addition of high vaulted porches and patios to the traditional hypostyle design. The influence of Seljuk architecture however can also be seen in the Jameh Mosque. The Seljuk Empire had extensive contact with the Byzantine Empire and their architecture quickly grew to incorporate a prominent feature of Byzantine design: the dome. As such, the Seljuk influence on Persian architecture can be seen in the two prominent domes in the Jameh Mosque. Indigenous domes had existed previously in the ancient near east. However, the spread of the Seljuk Empire saw the proliferation of domed mosques through the Islamic world. The Il-Khanid Empire, which lacked its own distinct architecture, quickly spread and adopted the vernacular architecture of Iran. Il-Khanid rulers invested much in aesthetics and innovative structural features such as transitional zones (going from an octagonal or square base to a circular dome through a series of pendatives and squinches). Indeed, the traditional Persian dome (as seen in the Safavid dynasty through the 17th century) is the Il-Khanid model with few changes. Due to the spread of the Il-Khanid Empire (as part of a larger Mongol advance into the near east), dome architecture spread to India where it was quickly picked up by the Mughal Empire, explaining the similarity in aesthetics and design between Persian and Medieval Indian domes (Ching,2011).

Marco Brambilla has provided all the necessary models and drawings of the building. Brambilla also points out the significance of the arch networks in the structural stability of the building as well as providing detailed drawings of their configuration. On the other hand, Vasseghi considered the whole building and dome as one unit. This method may be insufficient since a finite element model considers tension in masonry structures and the different components of the building were not modelled and tested separately on Soltaniyeh building. According to Vasseghi, an earthquake with a return period of 75 years will not cause significant damage to the structure. This is equivalent to a horizontal ground acceleration of 0.23g. An earthquake with a return period of 475 years will produce heaving cracking in the building. This is equivalent to a horizontal ground acceleration of 0.44g. An earthquake with a return period of 2500 years will cause complete failure and collapse. This is equivalent to a horizontal ground acceleration of 0.76g. This is a logical result given that the building, which is a seismically active zone, remains standing (Vasseghi,2007;221-227). The experimentation on the Soltaniyeh dome has revealed very important and interesting information on this extremely important historic structure. In vernacular architecture, a dome is an important element in terms of structure and geometrical expectation. Undeniably, Soltaniyeh dome is a phenomenal achievement of Iranian architecture.

Absence of dome in Iranian architecture and its re-emergence after Islam

The question often raised about domes in Iranian architectures is why this element is not seen in the architecture of mosques in the first Islamic centuries. There is a question if the mere reason of emergence of such an element has been the coverage of wide spans. In other words, if only the structural reason has been considered in building domes, why had the Iranians disregarded building domes in the mosques for centuries after the advent of Islam in Iran? If orientation of the Iranians towards this religion and necessity of collective prayer required a wide space, then why has this element disappeared in Iranian architecture and emerged after centuries? These are questions that are posed for Iranian architecture after Islam. Indeed, the

big question is if the domes can be regarded as Islamic elements that manifest deep meanings of Islamic beliefs?

To answer this question, we need to examine Islamic architecture thoroughly. Elements that are regarded as the main elements of mosque architecture in the Islamic periods could not be created suddenly. No doubt, these elements have the roots in the past eras and have passed an evolutionary trend. Many elements existing in the architecture of Islamic mosques are elements of Sasanid architecture used in the architecture of mosques after the advent of Islam.

"In Qal'eh Dokhtar in Firouzabad, a stairway that turns around the column is the primary form of mosque minaret in the Islamic period. In Bishapour palace, a yard around which there is an arcade is an element that later plays an important role in the mosque plan. The brick circular dome in Sarvestan palace entered into Islamic architecture" (Sadri, 1994). Other elements faded away for a while that were the most important elements of Iranian architecture in the Sasanid era. Among them, the dome, the porch and decorative jags can be mentioned. However, domes and porches returned to Iranian architecture after several centuries but decorative jags were forgotten forever. The question is why did it happen? Dome construction stopped for a while and architects preferred to cover the required space for prayer by many columns.

The opinions of Arthur Pope about absence and re-emergence of portico in Iranian architecture can be generalized to the absence and re-emergence of domes to some extent. As regards Madayen Portico, he believes that basically Madayen Portico represents strength and greatness of Sasanid dynasty (Sadri, 1994). The new Islamic government that had not become so far from authentic teachings of Islam did not need such strength; though this need was felt again in the subsequent eras. The great portico returned to Iranian architecture and was crystallized in the mosques. This can be extended to the domes. Dome was used in the architecture of imperial palaces so widely as if it had been a symbol of Sasanid Empire. In the first Islamic centuries, sensitivities to the removal of symbols and signs of the prior government was high. Anyone who tried to be far from those signs, particularly symbols of an imperial government could not be repeated in the architecture of the most important and sacred place in the Islamic government; the mosque (Sadri, 1994). Thus, the dome was removed from Iranian architecture consciously and later when the political sensitivities subsided or Islamic governments took the spirit of imperial regimes, dome was permitted to be brought back again. But what does dome mean and why has it re-emerged? How do the Iranian Muslim artists express Islamic teachings and deep mystical concepts in the artwork?

The Iranian architecture and roofed space coverage

Most parts of Iran have hot and dry regions and people of these regions have always encountered such problems as generally high temperature, as well as high temperature differences between day and night. On the other hand, woods present in Iran are not strong enough and are usually used for covering 2.5 to 3 m spans. In the periods after the Achaemenid era, it was not cost-effective to use woods due to the costs of wood transportation from such lands as Jebel Amel in Lebanon (Karim, 1991). These problems made the Iranian artists to use materials compatible with the climatic conditions of the region and accessed easily. Thus, soil was selected as the raw material of construction. Soil can be converted into brick and used in the construction of different elements including the roof.

Roofs built by brick in Iran can be divided into two; arched and domical types (Qobadian, 2006). Both types have been invented by relying upon features of brick that has appropriate pressure strength. Between them, dome that has an outer view besides covering larger spans has been widely used in the construction of important spaces.

Fig 2: motifs of the roof interior view in Soltanieh Dome (Source: Author)

Arches and domes, whether in the Parthian and Sasanid eras or in the Islamic period were built without the need to mould and control elements. Furthermore, use of modular elements in forming an integrated structure is regarded as one of the advantages of the Iranian domes compared to other prevalent models in the world; because this provides diversity in the produced forms, possibility of pre-building and controlling quality of the elements (Khodadadi, 2011).

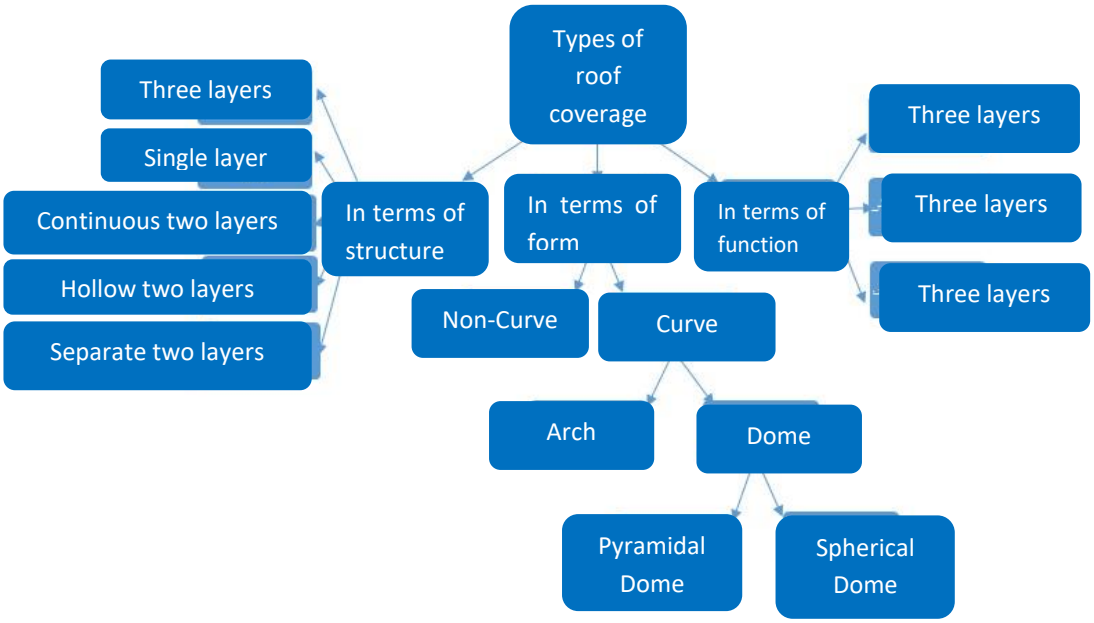

Fig. 3: classification of types of coverage in the Iranian architecture (Lorzadeh, 2005)

Classification of coverage types in the Iranian architecture
Types of circular domes in terms of arch type

All Chafds, arches and domes are divided into two elliptical and ogee groups. In the elliptical forms, peak of the arch is curve, but it is zigzag in ogee forms. Accordingly, the circular domical coverage is created by rotation of Chafds around their vertical axis. If the basis of rotation is ogee Chafd, the dome is ogee and if the basis is elliptical arch, the dome will be elliptical. Arches are divided into two ordinary and domical groups:

Ordinary arches: used on the entrance ports and gates, etc.
Domical arches: used in building domes (Lorzadeh, 2005).

Geometrical definition of dome

Dome is one of the characteristics of Islamic architecture and there are very beautiful examples of them in Iran. The blue color of domes and their curved form is balanced and spiritual, and glory and beauty of the Islamic architecture depend highly on the dome, which is mainly decorated by mosaic tiling. Dome usually refers to forms that are hemispherical. Dome has been a specific symbol in the ancient and religious lands and has been built on the tombs and religious places in gold or turquoise color. This element of Islamic architecture is indeed a manifestation of heaven and a sign of greatness and light. A dome also embodies the divine seat and it is seen as a divine spirit that has surrounded the universe (Zamani, 1984). In the geometrical definition, dome is the geometric location of points created by rotation of a certain Chafd around a vertical axis. However, in the architectural language, dome is a coverage built on a circular basis. Dome is composed of three parts (Zamani, 1984).

- Dome Base
- Bashn: a part on the basis that rises in a cubic form and one or two sides of it are open
- Chapireh

Since we rarely come across circular bases in Iranian architecture, and usually the ending part of Bashn has a square or rectangular form, it is converted into a circle and then the dome is placed on it. That is why Chapireh is important in dome construction because having a circular base makes the final implementation of a dome coverage possible.

Dome construction in the vaulted coverage of the Iranian old works like arch coverage of residential houses in Shahr-e Sūkhté have roots in the third millennium and elliptical arches in the lower floors of Choghazanbil and Shush buildings have roots in the second millennium (Zomrashidi,2010). According to Pirnia, in other lands (for example Rome), domes were semi-circular, while in Iran, we witness remarkable advancement of mathematics, geometry, and the use of them in architecture. Iranian architects did not consider the semi-circular form (and basically geometrical space) appropriate for coverage and selected such forms as oval and elliptical and semi-elliptical. This option (based on precise mathematical principles) let them consider the dome thickness as much as one sixteenth of the span (Karim, 1973).

After Islam (particularly in the first three or four centuries), since the Iranian Muslim architects did not like the glory more than the needed one tried to reduce the height of infrastructure as far as possible. Concurrent with the advancement of dome construction technique in Iran and later in other countries, some domes were built with the spans even larger than the Iranian domes but the Iranian dome has some features that have made it a masterpiece (Pirnia, 1973).

The position of dome in the Islamic architecture

The shrine of Imam Reza (PBUH), eighth Imam of the Shiites, is a unique collection of the sacred Islamic art in terms of architecture and other arts. In general, religious centers like mosques have common elements. These elements include apron, portico, porch, minaret, dome, nave, and niche. It must be noted that all of these elements may not exist in some buildings or may be more in some of them compared to the others.

It is among inherent features of the Islamic art that it seeks to create a space in which humans can gain their primary weight and inherent dignity. In the philosophy of this art, there must be no obstacle between humans and the invisible presence of God. In the first place, Islamic art creates a kind of gap and removes all worldly inclinations and distresses and then replaces a system that implies balance and peace. One of these arts is architecture that must create in the crowded places the harmony and peace existing in Nature.

Dome in Muslim architecture means target and reaching the target, i.e. Allah. From an architectural perspective, the concept of center has been realized in the dome that has surrounded the world like the divine spirit. In the Iranian culture and architecture, the form of dome has a particular position to the extent that it can be regarded as one of the representatives of the Iranian—Islamic architecture. Particular interpretations have always been mentioned for the form of dome; square or rectangular building has been regarded as the symbol of earth and dome has been called the symbol of heaven. Another interpretation of dome form is that its Stalactited arch is regarded as a ring linking the earth and the heaven. The Prophet Mohammad (PBUH) describes in Meraj narrative, a great dome made of a white shell and set on four bases at four corners. (Cultural heritage, 2003).

Fig. 4: Simple and pure space of Soltanieh Dome
(Source: Author)

Among specific features of the Iranian dome, its form and the method of its construction can be mentioned. In Iranian architecture, dome was built without using a mould but its order was so accurate that it had the best resistance against seismic forces. Stability of these buildings is another salient point that can be mentioned about domical forms (Tajvidi, 1971).

Domes that have a circular geometric form with a double curvature transmit weight forces and other forces to the support by the mechanism of membrane forces. The geometric

form of domes usually minimizes the tensile stress created in these forms. Thus, building domes by the materials of construction (clay, brick, and stone) that are not able to bear bending forces is quite possible. As regards evolution of building forms, domical-forms are superior to frame-forms and even arch-forms. Another advantage of domes is that the wind blows more easily on a convex surface and will have less erosion. In general, dome is the sign of mosque and is useful for taking the skylight. On the other hand, this element is a resistant and proper coverage for large spans and creates an adequate space for proper weather so that there is no problem in congestion. Minaret plays the role of glory and Qibla orientation, but dome and minaret cannot merely be considered as the structural elements; rather the role of dome and minaret in Iranian Islamic architecture must be known as symbols and codes and other applied matters must be understood. To build the first dome, Armenian flowers, water, grape sap, and goat wool were used and it was made of tile. The first dome is seen today from inside the sanctuary and the concave surface and mirrored stalactites are evident. At that time, this dome and the shrine were decorated by tiles known as Sanjeri, trimmed with verses of the Holy Quran, Hadiths, and Names of Allah (Zomrashidi, 2010).

Soltanieh Dome, a manifestation of Iranian creativity

Soltanieh, an emerald plain full of daffodils and tulips, has been a resting place for the government forces since entrance of Arghun Shah to Tabriz. It is claimed that it was the third great building after Hagia Sophia in Turkey and the Cattedrale di Santa Maria Del Fiore of Florence in Italy that has been built before the beginning of the recent civilization. In this paper, we study several salient samples briefly. From 40 km to Zanjan, on the left side of the road in a green plain, a great dome is seen. In the bright sunny weather, a major part of turquoise tiles of the dome that have been immune from damage of wind and rain and natural adverse events and foolish rubbers can still be seen. When we turn to left, every moment that we go ahead, the grandeur of the building evokes our praise and wonders more. A little has remained from ditch around Kohandej, towers, and minarets. However, the whole complex have remained quite healthy including the dome, the bases, the rooms and the halls.

Unfortunately, many black steel scaffolds surround the Soltanieh dome for repair for years as if they shatter the heroic body of the dome and as if they will remain as long as the age of the dome. They have reduced the glory and charm of the building highly. We enter from the public gate (the northwest porch), the northeast gate has been specific to the king's family. When we look at the building, the naked and scary 48.5m height of dome and its 25.60m arch span (approximately the height of a seven story building) causes dizziness. Maybe it strengthens our weak steps against gigantic civilization of the West a bit. Even today, this complex may be an example of art, grandeur and bright civilization of Iran compared to the Skyscrapers of the West. During the last 700 years, due to horrendous earthquakes, at least 90 percent of the city has been buried under soil. However, Soltanieh Dome has been subsided only five centimeters and there is only a small gap in a part of the dome.

Soltanieh Dome and its surrounding buildings were built over a period of 10 years. In the early 7^{th} century, there were no buildings anywhere in the world with this height and the octagonal building is crowned with a 50 m tall dome covered in turquoise-blue faience and surrounded by eight slender minarets. Indeed, it is the earliest existing example of the double-shelled dome in Iran.

Fig. 5: the landscape around Soltanieh Dome
(Soltanieh-wikipedia 2018)

Unique features of the Dome

For the first time in the world, Soltanieh Dome has been built in two layers and after construction of this dome, other countries and other parts of Iran has used this method. In studying historical works of Soltanieh, Hushang Sobuti states that "using a two-layer dome for having more inertia and reducing its bottom-up thickness and making it lighter represents the balanced relationship in the dome components. Now it is inferred that static calculations in all dimensions determine design and implementation of the elements of architecture in Soltanieh Dome" (Sobuti, 2005;176). The dome still seems healthier than other ancient places after seven centuries. This is due to multiple factors. For example, selection of land for constructing Kohandej is quite scientific and is based on unique standards.

The 9 m profile (borehole) existing in the dome underground represents the existence of technical knowledge of soil mechanics for selecting the best part with compact and robust texture of soil. To bear such a great burden - 1600 tones, foundation of the dome must have the strongest and most complicated materials. It is evident that after required tests of grading and ratio of sand, clay, and soil, percentage of humidity, depth of underground waters, and other similar matters, the foundation of the complex has been constructed. Foundations are at most 9 centimeter high and quite low. Foundations have been made of lime and plaster. The crypt connects the ground floor to the underground by beautiful stairs. It has multiple spaces and has mainly been made of integrated stones and probably the first grave of Oljeitu had been predicted in this crypt.

The ground floor has an octagonal plan that becomes rectangular in the first floor and has a regular octagonal plan in the second and third floors. In the ground floor, narrow and circular stairs open the way to the higher floors. It is surprising that at the first moment of entering the stairs, it seems that there is no possibility of passing while the space of the stairs has been designed in a way that any person with any step is able to pass from the stairs. The floors have porches and balconies so that if a leader does not accompany the visitors, they will become confused and will not find the main way to return. After the ground floor, the first floor includes vestibules. These vestibules have surrounded the building and create a 16-modal plan.

These vestibules have created broad and functional spaces. The roof of these spaces has been constructed with various forms by using brick, plaster, and stone. Functional spaces are composed of eight balconies with beautiful decorations including tiling, strapping, stucco, and integration of brick and tile and finally multiple inscriptions. “The vestibules overlooking the gate of the king’s family members has beautiful curtains as a matter of great magnitude and each porch has been converted into three arches symmetrically. Their roof decorations have provided the most beautiful and attractive decorations in stucco art of the building. In each porch, a window is opened to the dome house. The spiral staircase of the minaret begins in the ground floor and connects the second floor to the third floor" (Sobuti, 2005;56).

Fig. 6: vestibule space of Soltanieh Dome
(Source:Author)

Balconies overlook the city and vast emerald plains of Soltanieh. These porches were used in the ceremonies for the presence of authorities and probably for family rest and meetings. Perforated brick walls have been built with beautiful forms and very precise and scientific technical instruction. The ceilings of balconies with copper color have forms, flowers, and curvatures that have still their glory. One of the wonders of design lies in these ceilings. Stucco has been implemented in three levels in all forms so that it is regarded as one of the human-made masterpieces in terms of visual art. Balconies that overlook the dome house have wooden perforated fences connected to each other with no glue and peg but only by creating male and female gaps.

These fences are so strong that they have not deformed after seven centuries. Extremely beautiful and regular geometrical – symmetric forms have added to the glory and grandeur of the porches. Porches have been a gathering place for women of Oljeitu family (Najib, 2000). In the religious and national mourning ceremonies and celebrations, the Royal family and sometimes public invitees have used this place.

The porches ensure that the dome house is not visible from the bottom, but can be seen from the top easily. The frontage of the porches have been harmoniously created by using turquoise tiles and grass green and other gentle colors. The altar margins of the Quranic verses have been carved in very beautiful scripts. One of the frontages of these porches in the south side, has a 20 cm margin. Ayat al-Korsi1 has been written completely. In such a height, without modern advanced facilities, regulating dimensions and size of script and determining precise location of these Quranic verses is extremely difficult; yet achieved.

[1] Al-Baqara 255

Conclusions

Dome is one of the old forms in Iranian architecture and has been created before Islam. Subsequently, it has experienced multiple developments. In the Sasanid architecture, dome was one of the main elements of the government palaces so that it had become a sign of the Sasanid imperial government. After the advent of the new religion in Iran and orientations of the Iranians towards it, they refrained from using dome in the constructions. However, after several centuries, dome was no longer considered as the sign of Sasanid government and returned to Iranian architecture again. Yet this time, inspired by the Islamic mystical deep knowledge that had penetrated into the heart of the Iranian Muslims, they have sought to refer to those deep concepts in the artworks. However, by getting far from the time whose spirit was attention to God and spirituality and reaching the modern period and scientific and intellectual revolution, appreciating the message of those traditional forms that talk about the heavenly world has become difficult for the modern man.

Hence, some traditionalist scholars including Nasr and Burckhardt have tried to interpret those secrets. Domes used in the works of the Parthian era have been mainly circular with a height more than radius of a typical (lean-bearing) circle. Arches used in the buildings and works of the Sasanid era are horseshoe, semi-elliptical, elliptical, and Sasanid oval. Arches used in the first centuries after Islam was mainly semi-elliptical and later ogee arches. In the next periods, particularly Timurid and Safavid eras, decorative sharp arches were used. From the period after the Safavid era up to the present, no specific innovation has occurred in reducing dome leap and arches of the past periods have been used in various methods.

Soltanieh Dome has been used as a sundial. Noon was recognized from the light shining from the main opening of the ceiling. The light shining from large windows determines the approximate hour and the light shining from small windows determines the approximate minute. Some state that the crypt has existed before construction of the dome where shamanism ceremonies were held and the dead bodies were buried with their jewelries and tools; but there is no effect of shamanism tombs in the crypt. Even tomb of Soltan Mohammad Khodabandeh is not in this place. 110 stairs existing in this building is synonymous with the name of Imam Ali in Abjad letters and this indicates Soltan Mohammad's respect for Imam Ali. The important point about Soltanieh building is its relation with the political and social developments. Construction of this building is concurrent with the great and deep development of "the Iranian identity revival" and revival of the Persian language and Iranian traditions and so on. In the design and construction of the building, specific political and cultural goals have very likely been considered for reviving the Iranian identity and architectural traditions of Ilkhanid period have been modeled in its design. The purpose of building such a grand dome was the transmission of the holy shrine of Imam Ali (PBUH). This was due to Soltan Mohammad's inclination to Imam Ali. Soltanieh Dome may be regarded as the first artwork of the Shiites in Iran. After completion of the building, Soltan Mohammad gave up this purpose due to disagreement of the religious scholars.

This building has been repaired several times at different periods. Some repairs have been conducted in the Safavid and Qajar periods but the major repair of the dome is underway for several years. For 35 years, the scaffolds can be seen inside the dome space and below it that have been built by an Italian board of repair still exist with no fundamental change in the repair. Soltanieh has experienced two eight-Richter earthquakes and it is still strong. It was recorded in the world heritage list of UNESCO in 2005.

References:

Attarzadegan, N. (2010) "a study on the methods of Abolvafa Bozjani about division and combination of squares", Journal of Sciences and Technology Month, (the Iranian house of book), 3-7.

Cultural heritage (2003) heritage document center, Naqsh-e Ajab: a collection of plans of the Iranian historical buildings, V.1, Tehran: Cultural Heritage Organization (research center).

Ching, F. Mark J,& Vikramaditya, P. (2011) A Global History of Architecture. Hoboken, NJ: J. Wiley & Sons.

Critchlow K. (1976) Islamic patterns: an analytical and cosmological approach/ Keith Critchlow. New York: Schocken Books.

El-said I. & Parman. A. (1991) Geometric Concepts in Islamic Art. London: Interlink Publication.

Godard A & Yadda G. (2011) Arch in the Iranian architecture, translated by Humid Qara Guzlu and Saeid Saemi, Tehran: Modiran-e Emrooz Publication.

Haji Amini, & M. (2011) "digital interpretation of traditional geometry of the Iranian – Islamic architecture, design of Islamic art exhibition center", M.A. thesis for architecture technology, Tehran: Tehran University, Paradise of Fine Arts, Faculty of Architecture.

Kashani Q. J. (1987) Thesis of Architecture and Azj, translated by Seyed Alireza Jazbi, Tehran: Publication of the Islamic Republic of Iran Broadcasting (Soroush).

Khodadadi, A., Hoshyar N., Golabchi M., & Bozorgmehri Z. (2011) "the Iranian domes", the third national conference on the space structures, Tehran: Tehran University, Paradise of Fine Arts, Faculty of Architecture.

Kharazmi, M. & Afhami R. (2010) "applied geometry in the decorations of the Iranian architecture before Islam", Journal Sciences and Technology Month Book, Special Issue of Islamic Architecture, 8-13.

Kheiri A. (2010) "arch of the Iranian Islamic architecture in Meftah al-Jasab of Qiaseddin Kashani", Journal Sceinces and Technology Month Book, Special Issue of Islamic Architecture, 28-34.

Lorzadeh H.(2005) Revival of forgotten arts, basic principles of traditional architecture in Iran, Mola Publication.

Memarian Gh. H. (1988) vaulted constructs in the Iranian Islamic architecture, v. 1, Tehran: University of Science and Technology Publication

Mirabolghasemi S Mohammad T. & Bagheri M. (2003) "thesis of Abdorrahman Sufi about compass geometry", Journal of Science History, No. 1, 89-124.

Mehrpouya J. (1992) Geometry in architecture., developed by, Tehran: Cultural Heritage Organization,

Najib Oqlu, G. (2000.) Geometry and decoration in the Islamic architecture, translated by Mehrdad Ghayumi Bidhendi, Tehran: Rozaneh Publication.

Nasr Seyed H. (1996) Islamic art and spirituality, first edition, translated by Rahim Ghasemian, Tehran: Office of Art Religious Research

Neyestani J. (2005) "The background of drawing plan and applying geometry and mathematics in the Islamic architecture (from the first Islamic centuries to the mid ninth century)", Peik-e Noor – human sciences (Payam-e Noor University), 42-49.

Pope Arthur U. (2009) The Iranian architecture, Tehran: Samira Publication

Pirnia, M. K. & Bozorgmehri Z. (1994.) "Chafds and arches", Journal of Asar 24,

Pirnia, M. K. & Bozorgmehri Z. (1991) "Dome in the Iranian architecture", Journal of Asar 20

Pirnia, M. K. (1973) "the Iranian gifts to the world of dome architecture", art and people

Qobadian V. (2006) a study on the climate of the Iranian traditional buildings, Tehran: Tehran University Publication

Rasouli H. (2007) the history and methods of architecture in Iran, Tehran: Pashutan Publication

Sobuti, H. (2005) studying historical works of Soltanieh, Saheb Asar Publication, p. 228

Sadri Afshar Gholam H. (1994) Pope, Arthur Upham, the Iranian architecture, Tehran: Farhangan.

Tajvidi, A. (1971) "continuity of the Iranian architecture", art and people 111

Taghvaei, V. (2006.) "a review of existence degrees, with reference to geometry and beauty in the architecture of the Safavid era", PhD thesis for architecture, Tehran: Tehran University, Paradise of Fine Arts, Faculty of Architecture,

Tehrani, Mehdizadeh Seraj F. F, & Vali Beigzadeh N.(2011) "application of normal triangles in the mathematical calculations and implementation of geometry in the construction of the Iranian traditional architecture, "Quarterly for Cultural Historical works Repair (Research deputy of Isfahan University of Art), No. 2, 15-26.

Vasseghi, Akbar, Esghi, Sassan, Jabbarzadeh, Mohammad J (2007) “Preliminary Seismic Evaluation of the Historic Sultaniyeh Dome.” Journal of Seismology and Earthquake Engineering, Vol. 8, No. 4 pp. 221-227.

Zabihian B. Borough, E. (2008) The Islamic geometrical motifs, Tehran: Maziar Publication

Zamani A. (1984) "decorative dome in the Iranian Islamic historical works", the Iranian architecture, developed by Asieh Javadi, 845-853, Tehran: Mojarad Publication

Zomrashidi H. (2010) Dome and Vaulted elements in Iran, Tehran: Zam