

DOMES`S INTERNAL DECORATIVE ELEMENTS IN PERSIAN ARCHITECTURE CASE STUDY: YAZDI-BANDI

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Abstract

This paper describes and scrutinizes one of the patterns, referred to Yazdi-bandi, used to decorate the internal surface of domes and semi domes. Yazdi-bandi is one of the important decorative elements of Persian architecture. Therefore, comprehensive research on the identification and understanding the characteristics, and determine the exact geometry, and classification based on scientific methods seems imperative. The aim of this paper is to identify the unique features of the Yazdi-bandi as an Architectural-ornamental domes which topped a majority of distinct Interior domes during the early Iranian Islamic era. For this purpose, two samples were chosen out of a total of Yazdi-bandi in Iranian Islamic architecture. Through an analytic review of selected examples, the paper suggests and addresses the features of Yazdi-bandi domes, their formal morphological compositions and typological forms based on the number of their Internal from geometry in Iranian Architecture and nearby regions. This study aims are to demonstrate some ways out: Evolutionary Historical of Yazdi-bandi. The theoretical framework for the formal language of Yazdi-bandi domes sheds new light on undiscovered information about the essential characteristics of Persian ornamental domes in this region.

Keywords: *Persian architecture, Islamic Geometry, Dome`s decoration, Yazdi-bandi*

1 INTRODUCTION

This paper is about Yazdi-bandi, which is a kind of interior dome decoration in Iranian Architecture. Yazdi-bandi is the Persian word for interior dome and Iwan1 decoration. It is an originally Persian type of wall or ceiling decoration, which is used to make a smooth transition from the rectangular basis of the building to vaulted ceiling. However, Yazdi-bandi are not only used as a dome interior decoration. Yazdi-bandi also find on Iwan, for example it has generally been recognized that Yazdi-bandi whether as single buildings or in large complexes of buildings, have played significant role in ornament of Iranian architectural. They are different considerably in sizes and type and materials. We are thus conducted in order to test the

¹ *Iwan was a trademark of the Parthian Empire (247 BC–AD 224) and later the Sassanid architecture of Persia (224 -651.), later finding their way throughout the Arab and Islamic architecture ("Dictionary of Islamic architecture: Irvan"), An Iwan is a rectangular hall or space, usually vaulted, walled on three sides, with one end entirely open.*

applicability and suitability of the dome interior ornamental called "Yazdi-bandi ". For many years "Yazdi-bandi" has been utilized as a decorative pattern for interior place. In the history of "Yazdi-bandi" was never considered as a structural pattern (R.Aldecoa, 2010). Despite several existing studies about the Iranian ornament the Yazdi-bandi still does not have completely known architectural morphology, typology, geometrical context, and even associated terminologies. The study of characteristics of the Yazdi-bandi can be manipulated to give contemporary meanings to the traditional designs and principles of the ornament of architecture styles. Also, the developed geometric method has the potential to be used analogically in analyzing and understanding the essences of different sorts of the decorative of Iranian architecture. On the other hand, it can be said geometry is one of the main features in formation of Iranian architecture. Geometrical methods developed in the past cannot be successfully applied for vernacular architecture. The search of innovative geometry has been an interesting subject for Contemporary Architecture (Kourkoutas, 2007) Research in Iranian architecture geometry is impossible without familiarity with geometry. There have been no bright studies which compare differences in architecture technique and mathematics and geometric achievement. Ornament geometry Application in Iranian architecture in two forms: a scientific and practical. Science of geometry encompass the theoretical foundations and its practical aspects covers practices of the concepts, philosophical and mystical, that Iranian architects has benefited to creation of the masterpiece buildings. However, far too little attention has been paid to study the effect of geometry and mathematics in shaping Iranian architecture.

2 METHODOLOGY

As mentioned earlier, research in Persian architecture without knowledge of geometry is impossible. In this regard, this paper seeks to address the following questions: What is the relationship between the progress of Yazdi-bandi as a decorative element of Persian architecture and its geometry evolution. The research hypothesis is that evolution of geometry and decoration techniques, have a direct impact on the formation and

development of Iranian architecture decoration. This is a Fundamental-theoretical research paper. What we know about relation between architecture and geometry is largely based upon interpretive studies that investigate the progress of the Muslims in the Islamic and pre-Islamic historical texts. The study was conducted in the form of a historic-interpretative, with data being gathered via conformity of history, art and science architecture In the Islamic era and earlier, using available resources and library information. This study focuses on the promising pattern which is abundant in the Iranian architecture. This paper attempts to offer a variety of approaches and interpretations of the presence and use of mathematics and geometry in Iranian architecture. Within the framework in this study, the pattern of "Yazdi-bandi" is introduced as one of the decorative Iranian architecture.



Figure1: Yazdi-bandi in Abbasian historical house, Kashan-Iran

3 ISLAMIC GEOMETRY

The word geometry refers to the science of properties and relations of magnitudes such as points, lines, surfaces, or solids in space and the way the parts of a particular object fit together (Concise Oxford English Dictionary, 1999). Geometry is well known based on two Greek words "geo", meaning

the earth, and ‘metry’, meaning to measure. Geometry possesses abstraction and the capacity to express and reveal objectively immutable and spiritual truths. Geometry involves proportions and prime roots that are considered the most beautiful proportions (the proportions of beauty). As such, beauty, for the Muslim artists, is objective and self-expression of truths, which is the essential nature of beauty as Plato stated, ‘Beauty is the splendor of the truth’. Geometric proportions are used by Muslim designers as the most valuable tool of design process to produce ordered patterns that govern esthetic beauty in designed spaces, surfaces and objects. They present us the ‘Principles of Nature’ in their own language. By applying the golden mean (Phi) and the root proportions, geometric patterns are produced to be applied to the fields of building crafts, such as tiles, mosaic, plaster and wood, as well as to the field of book art. The striking beauty and harmony of the varieties of patterns that characterized the interiors as well as the exteriors of domes indicate the involvement of knowledgeable artisans or mathematicians of that time. The ‘ulema’² have been the biggest influence on formation of elements of architecture. For example, ‘Abu al-Wafa’ al-Buzjani’³ author of the most widely used books on architecture such as ‘Al-Handasa’⁴ and ‘Kitāb fī mā yaḥtaj ilayh al-ṣāni‘ min al-a‘māl al-handasiyya’⁵ are believed to have been written much later than the earlier manual, although, as the Encyclopedia of Islam suggests, it might

² *Ulama* (Arabic: علماء ‘Ulamā’, singular عالم ‘Ālim, “scholar”), also spelled *ulema* and “*uluma*”, refers to the educated class of Muslim legal scholars engaged in school

³ He was a Persian mathematician and astronomer who worked in Baghdad. He made important innovations in spherical trigonometry, and his work on arithmetics for businessmen contains the first instance of using negative numbers in a medieval Islamic text.

Buzjani was one of the leading astronomy and matematiations of the Middle Ages. With significant contributions in obsevational astronomy. His achivments in trigonometry paved the way for more precise astronomical calculation (Hockey, 2007, p. 188).

⁴ “The Geometry”

⁵ “A Book on Those Geometric Constructions Which Are Necessary for a Craftsman”

have been a collection of his lectures penned down by one of his students. It mentioned the interactions of artists and artisans with mathematicians on topics such as geometric constructions of ornamental patterns and the application of geometry to architectural construction. “The book came in thirteen chapters addressing the design and testing of drafting instruments, the construction of right angles, approximate angle trisections, constructions of parabolas, regular polygons and methods of inscribing them in and circumscribing them about given circles, inscribing of various polygons in given polygons, the division of figures such as plane polygons, and the division of spherical surfaces into regular spherical polygons. It also accommodated, says Suter, a large number of geometrical problems for the fundamental construction of plane geometry to the construction of the corners of a regular polyhedron on the circumscribed sphere (Nurit & Bosworth, 1997).” Or in other words, a great scientist, Ghiyāth al-Dīn Jamshīd Kāshānī⁶ who played a significant role in the interaction and concurrence among mathematicians and architects, by addressing the relation between architecture and mathematics in two areas of knowledge, theoretical and practical (Taheri, 2009), described practical methods (in designing, drawing and implementing) while elaborating Muqarnas⁷ construction and calculations (Al-Kashī, 1977, p. 37), which made it possible for mathematicians and architects to establish a common language. Al-Kashi uses geometry as a tool for his calculations, not for constructions. Besides arches, vaults, and domes, al-Kashi calculates here the surface area

⁶ *al-Kāshī* (c. 1380 Kashan, Iran – 22 June 1429 Samarkand, Transoxania), is the prominent mathematician and astronomer of ninth/fifteenth century of Islamic civilization who founded the scientific methodology in practical and theoretical knowledge of mathematics in islamic architecture. (Taheri, 2009, p. 77)

⁷ An architectural ornamentation reminiscent of stalactites, is a type of corbel employed as a decorative device in traditional Islamic and Persian architecture. Iranian architects take the form of small pointed niches, stacked in tiers which project beyond lower tiers, commonly constructed of brick, stone, stucco, or wood, clad with painted tiles, wood, or plaster, and are typically applied to domes, pendentives, cornices, squinches and the undersides of arches and vaults (Curl, 2006).

of a Muqarnas, to say, he establishes approximate values for such a surface (Dold-Samplonius & Harmsen, 2004). In 2007, Peter J. Lu of Harvard University and Professor Paul J. Steinhardt of Princeton University published a paper in the journal *Science* suggesting that Garih⁸ tilings possessed properties consistent with self-similar fractal quasicrystalline tilings such as Penrose tilings. This finding was supported both by analysis of patterns on surviving structures, and by examination of 15th century Persian scrolls (Peter & Paul, 2007). However, Gülru Necipoglu⁹ points out that we have no indication of how much more the architects may have known about the mathematics involved (Tongo, 2009). She demonstrate that drawings such as shown on scroll would have served as pattern-books for the artisans who fabricated the tiles, and the shapes of the girih tiles dictated how they could be combined into large patterns. In this way, craftsmen could make highly complex designs without resorting to mathematics and without necessarily understanding their underlying principles (Necipoglu & al-Asad, 1996). With all the definitions presented, what seems essential to say that the brilliance and elegance of Persian architecture was not devoid of geometrical involvement. While there are numerous research works examining the architectural features and aesthetical values of Islamic architecture, research works concerning this architecture from the analytical and technical points of view are still limited.

More precisely, this paper carries 2 objectives:

- Identify geometric Yazdi-bandi classified as one of the decorative elements of the Iranian Islamic Architecture
- Classification of Yazdi-bandies method

⁸ *Girih is an Islamic decorative art form used in architecture and handicrafts (book covers, tapestry, small metal objects), consisting of geometric lines that form an interlaced strapwork. In Iranian architecture, gereh sazi patterns were seen in banna'i brickwork, stucco, and mosaic faience work.*

⁹ *Director of the Aga Khan Program of Islamic Architecture at Harvard, HAA Department.*



Figure 2: Muqarnas in Mir-Emad mosque Kashan

4 PERSIAN INTERIOR DOME

4.1 Domes in Iranian Architecture

Iranian design is a rich art form with spiritual and meditative meaning expressed through its infinite pattern. The decorations of domes represent the sky, heaven and what lies beyond the "seven skies" (Sarhangi, 2004).

Domes are composed of surface or surfaces and ribs that distribute loads in plane or along the ribs.

Surface domes have greatest efficiency when resisting evenly distributed loads.

Ribbed domes have a greater capacity to resist asymmetrical loading domes can vary I kind according to the way they direct loads toward the ground .accordingly ,the system of domes is divided into seven primary subsystems ,”kaseh_sazi”¹⁰ domes and muqarnas domes. These subsystems

¹⁰ Making a decorative bowl covered in Persian architecture that consists of a combination of several pendants (pornaderi, 2008, p. 105).

are determined by the way loads are distributed along the surfaces or line of the domes and the degree of subdivision of their surfaces (Moussavi, 2009).

4.2 Different Kinds of Domes

Domes in Iran have two types first dome with second decorative domes, under these three main categories, many other types of domes can be

classified, such as Yazdi-bandi domes. In this context, there are two main possibilities, within which are three others, as listed as follows (Moussavi, 2009): **Yazdi-bandi is a derivative dome.**

Table1. Classification of Ornamental Domes

Types	Name Domes	particulars	3D Model Sample
Structural	Surface	distribute loads along a continuous surface	
	Ribbed	Distribute loads along the ribs and along the infill surfaces between them.	
	Stacked arch	Distribute loads along a surface which is composed of interlocking diamond shaped modules.	
Architectural - Structural	Kar_bandi	distribute loads along a surface which is formed by cross vaults and pendentives A small dome is often used to cover the oculus produced the combination of cross vaults and pendentives.	
	Kaseh_sazi	Distribute loads along a surface which is formed by shallow domes resting on a set of pendentives and pointed arches	
Architectural	yazdi -bandi	Distribute loads along a surface which is composed of interlocking diamond shaped modules.	
	Muqarnas	distribute loads along a highly subdivided surface ,formed by the stacking of a series of horizontal tracks which are in turn composed of four repeating corbelled elements.	

- 1.
- 2.
- 3.

- 4.
- 5.
- 6.

5 YAZDI-BANDI

Definition of Yazdi-bandi is difficult because someone like "Ostad Lorzadeh"¹¹ and "Saeed Fallahfar" classified it between Rasmibandi¹² and Muqarnas (Raeiszade & Mofidi, 1995) (Shaarbaf, 1993). In other hand "oastad shaarbak"¹³ classified it in karbandi group (Shaarbaf, 1993). Dehkhoda said in his Dictionary: Yazdi-bandi In terms of masonry is an ornamental element that used on the vaults (Dehkhoda, 1995). Local usage of "Yazdi-bandi" is mainly in interior dome, mainly entrance in masque and big houses.

This study focuses on the promising pattern which is abundant in the Iranian architecture for many years "Yazdi-bandi" has been utilized as a decorative pattern for interior place in the history of "Yazdi-bandi" was never considered as a structural pattern (Shaarbaf, 1993). The Yazdi-bandi dome base unit is a tier, or track, composed of smooth. Finely grained, diamond shaped modules of different sizes, with very small flat and horizontal star shape pieces in between. Each tier interlocks with the tiers above and below. Yazdi-bandi domes direct the loads along the diagonal borders between the diamond modules, and along the surface between these lines. The distribution of loads along the lines and surfaces of Yazdi-bandi dome embeds it with an optical affective property of diamonding and gradation that remains consistent within any space it defines. The variation of curvature of Yazdi-bandi domes creates an acoustical effect of diffusion that

¹¹ Lorzadeh in all fields such as architecture formalization, Mogharnas bowl, and skill of the nodes. If the architecture in an overall perspective, we, the biggest feature is that their concept lax. In fact, the biggest and most common way is to do the work at the top, thanks to the degrading and not man (mofid & raieszade, 2005, p. 14).

¹² Manner *Karbndy* the intersection of the arc, there are a few on *Trnbhha* and slim leg comes up (seyyed sadr, 2002, p. 306).

¹³ Ali Asghar Shrbaf (born 1932, Tehran), Master of traditional architecture and restoration of monuments in Iran. Tehran is one of the last remaining traditional architects A.A. Shrbaf.

dominates any focusing form the overall dome shape. This diffusion is enhanced by any diamonding of the surface (Moussavi, 2009). The Dome of Yazdi-bandi paved the way for more daring Iranian-style cupola ornament constructions in the Muslim world, such as the Mausoleum of Khoja Ahmed Yasavi and the Taj Mahal. Much of its exterior decoration has been no decorations, but the interior decorates superb Patterns, brick, and stucco.

6 BACKGROUND

6.1 History Researches

In this section, comprehensive research has been done. This previous studies conducted in this area can help us to use it in our studies for find a good result.

6.2 Historical outline of the origin and development of the Yazdi-bandi in historical architecture

7 History of Yazdi-bandi

In the middle of the tenth century Yazdi-bandi began to develop in Iran. Although the developments occurred simultaneously, it is not known whether they were related. Yazdi-bandi spread throughout the Islamic world from the eleventh century on.

In Seljuk, Ilkhanid and Teymurid other materials were used than those who were custom in Safavid period. Instead of "sun dried bricks", also stucco and tile were used to build a Yazdi-bandi. This led to the creation and evolution of original Yazdi-bandi styles. Therefore there are many different styles of Yazdi-bandi which cannot be properly categorized. Unfortunately, after the end of the Qajar dynasty in 1925 the traditional Yazdi-bandi culture stagnated because of the modernization.

	samples	author	Hypothesis or question	method	Case study
History Researches and the others	1	Alain Juhel's 2012	overview of the presence of mathematics in Persian architecture	Focused on different kinds of symmetries, starting from the simplest and oldest to those that are more complex, disregarding chronology or geography within the lands of Persia.	complementary set of selected pictures of Persian
	2	Mahsa Kharazmi, Reza Afhami and Mahmood Tavoosic 2012	examine pre-Islamic ornaments of the Sassanid period in regards to geometric frieze-patterns	This article contains drawn analyses of various types of patterns that in repetition create groups of associated forms	id stucco ornament such as: motifs as part of the whole
	3	Carol Bier 2012	critical study of overlapping polygons and radial symmetries	includes analyses of the geometric patterns that appear on the tympanum at Gonbad-e Surkh in Maragha and on the western tomb tower at Kharraqan	the overlapping polygons and radial symmetries of the tympanum and the pentagons and squares of the tympanum of the later octagonal tomb tower nearby
	4	Maryam Ashkan and Yahaya Ahmad 2012	introduce typologies of dome structures and their tectonics	examining a variety of dome structures across history	conical and polyhedral domes from the Seljuk era throughout the Timurid period in Iran and nearby regions
	5	Hooman Koliji 2012	role of geometry in vault structures	interpretive -intellectual	Friday Mosque in Isfahan
	6	B. Lynn Bodner's 2012	Euclidean Constructions of Two Nine- and Twelve-Pointed Interlocking Star Polygon Designs	analysis of two star polygon girih patterns used from the fourteenth to the seventeenth centuries	Girih with Persian origin
	7	Carl Bovill 2012	discussion of the use of tessellations in pre-modern Iranian ornament	looks into the geometric patterns of Mirza Akbar, an architect of late-eighteenth-century Qajar, Iran.	tessellations designed by Mirza Akbar in the early nineteenth century
	8	Reza Sarhangi 2012		study a series of Persian mosaic designs that have been illustrated in scrolls or decorated the surfaces of old structures.	particular series of Persian mosaic designs illustrated in historical scrolls and appearing on the surfaces of historical monuments

Table 2: History Researches source: authors

These Yazdi-bandis were constructed during the Il-Khanid dynasty, which took place in the thirteenth century. In this period Iran, along with parts of Iraq, Afghanistan, Turkmenistan, Uzbekistan and Azerbaijan, was under the reign of a Mongolian ruler (a grandson of Ghengis Khan). Il-Khanid Yazdi-bandi are a type of brick Muqarnas (according to instance of ornament materials in this period).

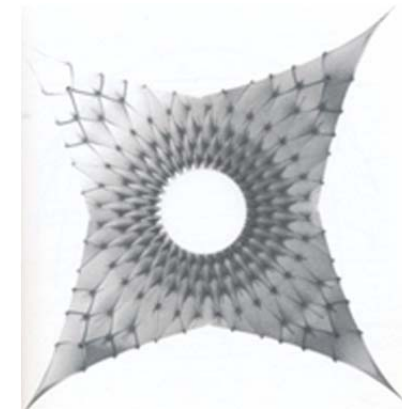


Figure.3: Yazdi-bandi, *The Function of Form*, source: (Moussavi, 2009, p. 280)

7.1 Historical background of the mathematicians' role in the design of Yazdi-bandi

In an aforementioned development treatise of the geometric ornaments, the role of the mathematicians can't be overlooked. Overall speaking, the Iranian mathematic in contrast with the Greek mathematics can also be called “the mathematics of practitioners due to close relationship of theory and practice (Özdural, 2002). Its proper demonstration can be derived from the works of al-Buzjani’s student who recorded contexts of his meetings with master builders and architects to discuss solutions to construction problems [Özdural 1995].

Yazdi-bandi, however, present a wide variety of sizes and types, but some geometric properties were repeatedly used in their composition designs. Nevertheless, no two samples are exactly the same. Visually, the analysis of

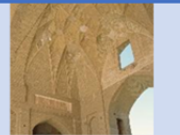


the pattern of samples revealed three classifications of morphologies. Which embrace the different geometrical properties and architectonic characteristics.
















This paper explores Generative Design by means of new Form-finding method application that adopts an idea from Iranian Architecture by evolutionary algorithm (Rasuli, 2010).

7.2 Types of Yazdi-bandi - The morphological features of the Yazdi-bandi in Iranian architecture

Since it is difficult to count the various types of Yazdi-bandies, the next part will discuss only the most famous types of Yazdi-bandies used in Iranian’s architecture. From the historical point of view, there are 8 types of Yazdi-bandies that were used frequently almost in all of Iranian’s buildings.

Table 3. Yazdi-bandies classification based on the historical period, Pictures from Aga Khan Archive. MIT, (www.Archnet.org, n.d.)

Historical period	description	Name	location	material	Building type	Location in the building	picture
Seljuk 1037_1194 AD	Yazdi-bandi is Simple and unadorned	Masjid-i Jamei	Iran-Ardestan	Brick and stucco	mosque	Porch	
Ilkhanids 1256_1335 AD	Yazdi-bandi combined by other ornament	Abdol-azim shrine	Iran Rey	Brick-tile	shrine	Porch	
Temurids 1370_1507 AD	The term of creating Rasni_Bandiani Kar_Bandi and Muqarnas	Labi Hauz Ensemble	Uzbekistan Bukhara	stucco	Garden House	Porch	

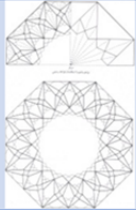

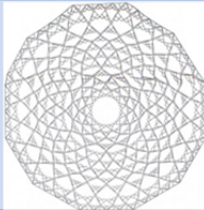
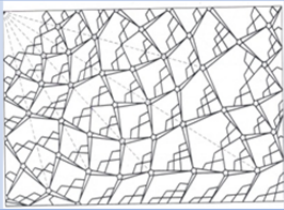

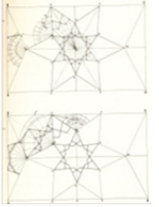

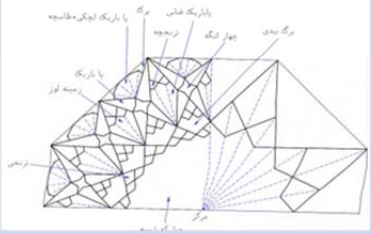
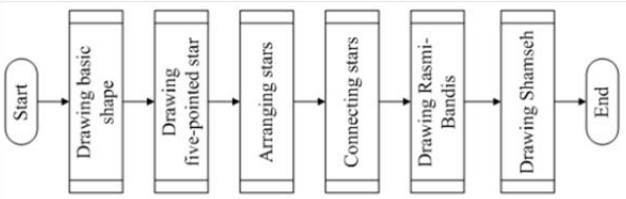
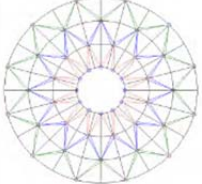

Historical period	description	Name	location	material	Building type	Location in the building	picture
Safavids 1501_1736 AD	Prevalence use of Kar_bandi and Yazdi_Bandi	Asefkhah tomb	Pakistan Lahore	Tile- brick	Tomb	Porch	
		Dia Anqa Tomb	Pakistan Lahore	Stucco with color	Tomb	Dome	
		Jahangir Tomb	Pakistan Lahore	stucco	Tomb	Porch	
		Diwan_i_ Am	Pakistan Lahore	stucco	Palace	Dome	
		Lahore Fort Complex	Pakistan Lahore	Tile	Fort Complex	Porch	
		ShahBuj	Pakistan Lahore	Mirrors	Garden Pavilion	Dome	
		Wazir Khan Mosque	Pakistan Lahore	Tile	Mosque	Porch	
		Badshahi Mosque	Pakistan Lahore	stucco	Mosque	Porch	
		Taj Mahal Complex	India Agra	stucco	Tomb	Dome- Porch	
		Hasht behesit	Iran Esfahan	Tile	Belvedere	Dome	
		Nadir Divan Beg Khanqah	Uzbekistan Bukhara	Tile	Khanqah	Porch	
		Ab-d-al-Amz Khan Madrasa	Uzbekistan Bukhara	stucco	School	Dome	
		Piruya house	Iran Naein	stucco	house	Porch	
		Chahar soghe Garjalikhan	Iran Kerman	stucco	bazar	Dome	
Hamman Garjalikhan	Iran Kerman	stucco	bath	Door way			

Continued Table 3. Yazdi-bandies classification based on the historical period (Safavids), Pictures from Aga Khan Archive. MIT, (www.Archnet.org, n.d.)

Historical period	description	Name	location	material	Building type	Location in the building	Picture
Zandiyeh 1760_1794 AD		Ameri house	Iran Kashan	stucco	House	Porch	
						Dome	
Qajars 1766_1925 AD	Use of Yazdi_bandi in most building	Erojerdi house	Iran Kashan	stucco	House	Dome	
		Tabatabaai house	Iran Kashan	stucco	House	Dome	
		Abbasian house	Iran Kashan	stucco	House	Dome	
	AMEN AL DOLLEH BAZAR	Iran Kashan	Erick	Timcheh	Dome		
	Nemat alah wali shrine	Iran Mahan	Erick	Shrine	Dome		
	Nasir akrok	Iran Shiraz	Tile	mosque	Porch		
	Zinat ol mok house	Iran Shiraz	Stucco	house	Door way		
	Hajeb oddok bazar	Iran Teheran	Stucco_ Erick	Bazar	Dome		
	Sardar mosque	Iran Qazvin	Erick	mosque			
	Sulbiye mosque	Iran Qazvin	Erick	mosque			
Pahlavi 1925_1979 AD		Qom timcheh	Iran Qom	stucco	bazar	Dome	
		Sepahsalar madrese	Iran Teheran	Stucco	school	Porch	
Islamic republic of Iran	Use of pre_fabricate panel of Yazdi_Bandi	Hur ste Masomeh shrine	Iran Qom		Shrine		
		Midatsham school	Iran Kashan	Stucco Panel	School	Doorway	
		Mossallih Ehsan Khomeini	Iran Teheran	Stucco Panel	Mosque	Dome	

Continued Table 3: Yazdi-bandies classification based on the historical period (three period), Pictures from Aga Khan Archive. MIT, (www.Archnet.org, n.d.)

Table 4: Different Method of Yazdi-bandi Drawing

designer		Method			
1	Hussein lorzadeh				
2	asghar sharbaf				
3	hossein zomarshidi				
4	Peyman Rasoli & Aazam Bastani far				 

8 CONSTRUCTION METHOD

A Yazdi-bandi consist of tiers (layers), which themselves consist of elements. Among these basic elements we can distinguish "Star" and "pa-barik". The stars and pa-barik makes cells. The cells look like small small piece of vault. They are the most important in building a Yazdi-bandi, since they provide the `body` of the Yazdi-bandi. The intermediate elements can be used to combine cells together, although they are not essentially needed and can be omitted.



Figure 4. Creating of Yazdi-bandi-Kashan

9 CASE STUDIES

This study uses only as a benchmark to modeling, and not to the exact values of these parameters for a particular type of structural space presented.

9.1 AMIN-AL-DOLLEH -TIMCHEH (ARCADE), OSTAD ALI MARYAM¹⁴, KASHAN, IRAN, 1900

The nave of AMIN AL DOLLEH arcade is formed by the vertical tessellation of a horizontal tier composed of a pendentive _like surface form

¹⁴ The famous architect Ustad Ali Maryam Kashani, Iran 19th century. Among his famous works are: Home Brvjrdyha (1857), Home Tabatabaeian (1840), Timcheh Aminodoleh.

an octagonal plan with eight pointed arches of differing scales on the perimeter to a hexagonal top in the form of a compression ring .the surface is subdivided into a triangulated grid in which each of the facets is kept at approximately the same scale .the scale of subdivision of the pendentive surface is set by the diamond grid, the scale and density of which changes gradually. Through a series of horizontal tiers. To adapt to the contours of the surface .the nave AMIN-AL-Dolleh arcade transmits an optical effect of diamonding, cruciform, gradation and rotundity, and an acoustical effect of diffusion.



Figure 5. Amin-od Dowleh Timcheh, Kashan Bazaar

9.2 Borujerdiā Mansion¹⁵, Hājj Sayyed Ja'far Naṭanzi, kashan, Iran, 1892

The Borujerdiā Mansion. Constructed in 1875, this house is one of the most famous historic mansions in Kashan. It was commissioned by Hājj Sayyed Ja'far Naṭanzi, a Kashan merchant who imported goods from

¹⁵ Home Brvjrdyha historic city of Kashan is. The building is located in the neighborhood of Sultan Mir Ahmad made in the second half of the 13th century AD

Borujerd (explaining his appellation). The construction of the exterior guest house spaces (biruni) and the interior private living spaces (andaruni) was completed in 1892, 18 years after it was begun, and more than 150 masons, stucco carvers, mirror cutters, and other artisans took part in its construction (Naraq, 1969, pp. 288-92.)

The south ensemble of the house includes a large "Talar" which is covered by the large dome features of yazdi-bandi and rasmibandi decorations, and alternating light apertures which give it a distinctive appearance, seen on many postcards from Iran (Sarhangi, 2004).

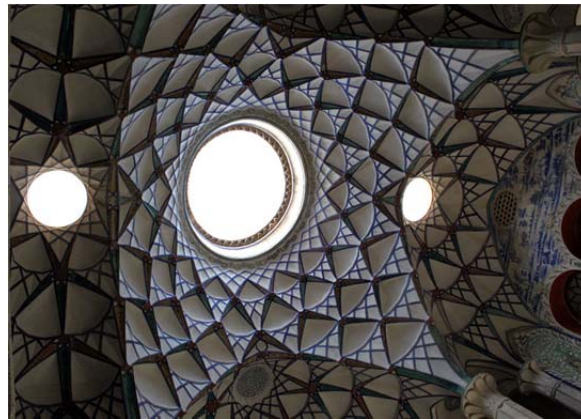


Figure. 6.: Khan-e Borujerdi. Niche with muqarnas at the rear of the living room

10 CONCLUSION

As noted, geometry is one of the main features in formation of Iranian architecture. Research in Iranian architecture is impossible without being familiar with ornamental geometry. So far researches have only applied to development of geometry separately, not on technical root of Iranian architecture. This paper attempts to address the following questions: What is the relationship between the progress of Yazdi-bandi and geometry evolution. The research achievements was that Evolution of mathematics

and geometry, have a direct impact on the formation and development of Iranian ornament architecture. One question that needs to be answered however, is whether the evolution of mathematics and Geometric influence the development of Iranian architecture. According to the findings of the theoretical and practical aspects of research, this paper can be the basis for future studies on the geometry in the Iranian architecture. A strong relationship between Iranian architecture progression and evolution of mathematic geometry has been reported in this literature. The most interesting finding was that by development of mathematic geometric, architecture has progressed and with the fading communication between mathematicians and architects, manufacturing techniques of buildings has deteriorated. However Future studies on the current topic are therefore recommended. More research on this topic needs to be undertaken to association between Architecture and mathematic geometry is more clearly understand.

11 FOOT NOTE

Because it was also found that most papers used terminologies specific to Persian architecture, which may be foreign to Western readers, the board decided to provide the following brief glossary.

Bazaar: A bazaar (from Persian (bazar), meaning "market"; from Middle Persian (bahā-chār), meaning "place of prices") is a permanent enclosed merchandising area, marketplace, or street of shops where goods and services are exchanged or sold. (www.en.wikipedia.org, 1985)The term is sometimes also used to refer to the "network of merchants, bankers, and craftsmen" who work that area. (Pourjafar, Nazhad Ebrahimi, & Ansari, 2013). The Turkish word bazar derived from the Persian "Pazar" (Petersen, 1996, p. 33).

Gunbad:an Iranian and Mughal term of dome, usually used for a domed tomb (Petersen, 1996, p. 103).

Kar-Bandi: The interface between design Foursquare far stems dome where it starts, if there is a sub-arcs of intersection, say Karbandy (seyyed sadr, 2002, p. 439). Karbandy building consists of a vault door is covered with geometric rules that determine arcs intersect and shape to create the original cover. Karbandyha, consisting Azbarykh or vault door are a Tqatshan, skeletal covering for ceilings occur and much of the time frame covered by the second and shorter than the main roof, and often as the main roof of used.

Rasmi-Bandi: Technical terms used by masons and architects as an act of making interlocking patterns in construction (Fallahfar, 1999). Muqarnas: muqarnas is one of the most characteristic features of Islamic architecture and in used throughout most of the muslim world (Petersen, 1996, p. 206). Stalactite-like structures built and hung under vaults or half-vaults. These structures were built out of plaster of paris in horizontal layers and vertical faces and were often covered with glazed tiles, colored glasses, and mirrors.

Yzdybndy: particular type of Karbandy under the dome , covering the decorative arched entries that are normally present in the atmosphere which gives specific expression. Yazdi is a state Ranking the Rsmbybndy and Mogharnas (seyyed sadr, 2002, p. 600).

Talar: Talar (Persian words) is the architectural term given to the throne of the Persian monarchs which is carved on the rock-cut tomb of Darius at Naqsh-e Rostam, near Persepolis, and above the portico which was copied from his palace. (www.en.wikipedia.org, 1985).in other definition: Iranian term of hypostyle wooden hall which procced through the main part of a building (Petersen, 1996, p. 276).

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