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STUDYING LIGHT-CATCHING ELEMENTS OF QAJAR MOSQUES IN SHIRAZ

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Abstract

Light is one of the factors affecting the space value of Islamic architecture and represents texture to the painted and brick surfaces in the form of quality. Light passes through wooden windows, plaster and marble walls, glasses of marble reliefs and makes the designs of interior places visible. Additionally, it creates a periodic coverage for colours and shades, and it reveals a strong presence at mosques from the two functional and mystic (a symbol of God's presence) aspects. This study attempts to investigate the light-catching elements for the Qajar era mosques in Shiraz in order to identify the abundance of them and also the state of taking advantages of these elements. Therefore, we aimed to categorize and detect the level of importance for each architectural element which is associated with the light in Iranian mosques. This study was conducted based on the hypothesis that implies the components of mosque architecture are able to be categorized from the aspect of dealing with natural light. In addition, these components and elements have been wisely located in the building with respect to the direction of radiation and intensity of the sunlight. In this research, by assistance of utilizing both methods of field and library studies, 10 samples of Shiraz Qajar mosques were classified and were selected by considering the well-known local mosques simultaneously (This is based on the library research and documentations which are cited by Cultural Heritage, Handicrafts and Tourism Organization of Iran). The findings of this study reveal that there is a significant relationship between skylight elements of Islamic architecture and direction of skylight, which, in turn, indicates that Iranian architecture has mixed functional and climate attributes of building with mystical and meaningful aspects.

Keywords: day light, lighting, light-catching elements, mosques, Qajar era

1. Introduction

Most scholars believe that the intensity, kind of source, colour, direction, and light distribution technique in various areas of human activities may affect his/her behaviours, moral, efficiency, and effectiveness in large extents. In addition, the role of natural light as the most perfect and desirable light is undeniable [1]. Day light has implied a valuable position in Islam. Iranian architectural areas have always been full of visual and spiritual manifestation of

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light [2]. Indeed, the motivation of turning into the light while worshiping God, has long been existed in various religions [3].

Islamic architecture, especially in Iran, has considered special emphasis on light [4]. The interior atmosphere of mosque is expressing that the light is appearing within materialistic forms and thus it reminds the believer the Noor Quranic verse: "Allah is the light of the Heavens and the Earth".

Light is the most effective part of Iranian architecture, not only as a physical component but also as a symbol of divine wisdom [5]. Additionally, the existence of light is a spiritual presence that penetrates the heaviness of the material and transforms it into a new form that values the human soul's habitation. It is just similar to its nature which is based on spiritual world [6]. Islamic architecture is truth-seeker and its truth is to achieve the perfection and essence of God [7]. The use of natural light as one of the basic principles of Islamic architecture in mosques` architecture, especially Iranian mosques, has greatly enhanced the sense of spirituality and has increased the revelation of this spiritual truth. Sacred art in holy places like mosques is important in terms of the growth and excellence of human spirit [8]. Therefore, the importance and role of light in the Iranian mosques should be examined and expressed in order to be used wisely in the atmosphere of current mosques.

This paper tries to identify the frequency and the state of utilizing light-catching elements of Qajar mosques in Shiraz. The main question is whether the light-catching elements in Iranian mosques have been wisely determined from the aspect of geographic direction? In other words, is there a significant relationship between the light-catching elements which are used in Islamic architecture and lighting direction?

The purpose of this article is to achieve a classification that identifies the importance of each natural light-related architecture component of mosques in Iran. The present study is based on the architecture of the mosques that can be categorized from the aspect of dealing with natural light according to the radiation direction and sunlight intensity. At first, a brief explanation of the light-catching elements and their role in mosques' architecture is expressed and afterwards how these elements were used in the analysed mosques, including Qajar mosques in Shiraz. Thus, ten sample mosques were selected and analysed through maps, visual information; and visiting samples location were used in order to study how these light-catching elements have been utilized. In addition, the question which implies what's the quantitative and qualitative function is answered. The results of the study are represented in tables.

In this research, a quantitative research method has been used with an analytical-descriptive approach. Most of the research work has been done through objective observation. In fact, in the present research, the objectives are achieved based on a logical review method and descriptive analysis. Literature review along with field surveys are used as research tools. In the theoretical part, we presenting different perspectives from literature and analysing them we tried to consider all possible aspects of the subject. For the case study, based on the

variables which were obtained in the theoretical part, the main indicators were assessed and evaluated.

2. Components and elements related to light in Islamic architecture

Light, as the source of brightness, has always been applied from the strongest to the weakest spectrum in religious places, including mosques. Another usage of light in mosques can be known as natural heating which is based on the light-catching element [9]. Other usages of natural light is creating weak and strong penumbra, which is depended on the type of materials and their functions; in turn, it creates different effects that each has its own nature. According to the studies, elements and components related to daylight in Islamic architecture can be mentioned and summarized as follows [10-13] (Table 1).

Table 1. Components and elements of Islamic architecture related to daylight.

Element's name	Definition	Figure
Jam Khaneh	There are openings in the domes and colombos' (little domes in Iranian architecture) stigma that are shaped in the form of an embossed cupola or pile with a few pottery [10-12].	
Horno	It is called the ceiling lightning. In the vicinity of the dome tip, they do not fill the hole to do the photoconductivity at the top of the vault [10].	
Roshandan	In buildings which implementing windows in the walls was not possible, including bazaars, architects have created openings in the coffering part of Rose window, which provides the best possible lighting and ventilation. It is named Roshandan [10].	
Grille	A grating plane is comprised of two full and empty spaces, in a way that from one side, the other side is visible [10, 13]. This grating decreased the light intensity and dimmer light was allowed through it [10]. A kind of pottery grating is installed on openings in buildings [11].	

Fakhr-o-Madin	Fakhr in Persian means baked clay. In Arabic, baked clay is named Fakhoori and its maker is called Fakhar. Madin means pistil, hole, and concavity [11]. Such walls were made with pieces of baked clay in the form of geometric and non-geometric shapes [12].	 
Sash window	A lattice window is lifted up instead of opening from the side [10, 12]. And is placed in the intended chamber. Sash windows are usually seen in the entresol of belvederes, and porch and ambulatory of buildings in the cold climates. The lattice pattern of sash windows is usually similar to wooden windows and openings [10].	
Lattice doors and windows	One of the earliest methods of daylight-catching which has been built in different sizes is based on the amount of light that enters the building. In areas with more intense sunlight, the window should be built proportionate to the light intensity. Lattice windows create balance between the outdoor and indoor light. Sometimes, glass is used for the lattice doors and windows [10].	  
Opening	Openings and windows cannot be differentiated from each other[10]. In fact, an opening can be known as a small window which is usually used at the top of the door in order to allow the daylight inside [10, 12].	
Goljam	Small tinted glasses are embedded at the top of the doors and large extents of the room provide lighting in the building. Goljam also refers to the plaster network and glass instruments which are used at the top of the door [10].	 

Frieze and Pulvino	Pulvino is a decorative pattern which is created with pieces of carved bricks and ceramics and is placed in the entablature of the building, middle of the pillars and door friezes. In order to allow daylight and air into the rooms, plaster plates are punctured and patterns are created. Then, those plates are placed over the doors and windows [10].	
Rose window	A fixed window over the doors and windows. Usually are made with girih tiles. The lunette over the doors and windows is called a rose window [12].	
Coffering	In spaces where the light-catching and space lighting is done through the roof, coffering produces a uniform dispersion of light and improves spatial quality [10].	
Muqarnas	In addition to beautifying the space, cofferings and muqarnases are used for the purpose of better utilization of the sunlight in a way that uniform dispersion of light is achieved and spatial quality is improved [10].	
Vestibule	Other important architectural factors in refracting the light are the entrance vestibules which are built in the form of round or polygon shaped. There is usually a skylight over the vestibule that allows a gentle concentrated light inside for various hours of the day [10].	
Portico	In regions with high sunlight intensity, it allows a gentle and proper light inside and therefore, lighting is provided indirectly or through an intermediate space [10].	

Sunbreaker	Usually a bond timber is installed over the door and window which is actually a horizontal sunbreaker and is called Sar Sayeh [11].		

All photos were taken by the authors from Nasir ol Molk mosque, Haj Bagher mosque and traditional mosques and houses of local Sange Siah district in Shiraz on 2018 (moreover Jam Khaneh and Roshandan which are in Lar, Fars, Iran taken on 2011).

Light-catching elements can be divided into three categories of light controllers, reflectors and light-catchers in traditional architecture. Light controllers are included porticos, sunbreakers, awnings, Sabat (Roofing structures with street beneath it in Mediterranean and Middle Eastern architecture for cooling purposes for pedestrians) and curtains of which can adjust the light entry. Light-catchers like openings, grilles, and lattice doors and windows are amongst light transmitters and light reflectors. These include Coffering and Muqarnas, which are elements that contribute with the uniformity of space and light distribution (Table 2). According to this study, the light-catching elements in Islamic architecture have been divided into four general categories:

1. Skylights including Jam Khaneh, Horno, and Roshandan;
2. Wall light-catchers which contain lattice light-catchers (such as Grille, Lattice doors and windows, sash window, Fakhr-o-Madin) and Non-lattice light-catchers (such as Opening, Goljam, Frieze and Pulvino, and Rose window);
3. Light reflectors including Coffering, Muqarnas, and Vestibule;
4. Light controllers which are consisted of Portico and Sunbreaker.

Table 2. Light-catching elements in Iranian traditional architecture (natural light) - classification.

Skylight	**Wall light-catcher**		**Light reflector**	**Light controller**
	Lattice	**Non-lattice**		
Jam Khaneh	Grille	Opening	Coffering	Portico
Horno	Lattice doors and windows	Goljam	Muqarnas	Sunbreaker
Roshandan	sash window	Frieze and Pulvino	Vestibule	-
-	Fakhr-o-Madin	Rose window	-	

3. Selection of case studies

The architecture of mosques in each country is illustrative of native architecture features of that country. In Iranian mosques, various architectural designs such as shabestan, chartaghi, one-iwan, two-iwan and four-iwan can be seen in different arrangements. (Iwan is a rectangular hall or space, usually

vaulted, walled on three sides, with one end entirely open.) Each of which represents a period of architecture history and conventional style in a region of the country [9].One of the characteristics of Qajar mosques is their four-iwan pattern [14], such pattern was not found in the studied samples of Qajar mosques in Shiraz. The reason is the fact that Qajar mosques in Shiraz were related to certain localization and neighbourhoods. In this study, Qajar mosques in Shiraz have been identified based on the previous studies and the sources from the Fars Cultural Heritage, Handicrafts and Tourism Organization. In Qajar era in Shiraz, 17 mosques were found and categorized based on the number of iwans (13 mosques with no iwans, 3 two-iwan mosques and 1 three-iwan mosque). We tried to select mosques from the three categorizations of iwans in a way that in the end, the selected mosques were included all the three periods of the Qajar era and either the both significant and local mosques (Table 3).

Table 3. Introducing sample mosques.

Building name	**Nasir ol Molk**	**Moshir ol Molk**	**Mirza Hadi**	**Aqa Lar**	**Haj Baqer**	**Fat'h**	**Haj Qani**	**Siavashan**	**Baqdadi**	**Emam Ali**
Iwan type	2-iwan	3-iwan	2-iwan	2-iwan	no iwan	no iwan	no iwan	Third period	Third period	no iwan

4. Evaluating the use of each light-catching method in samples

Based on the conducted studies and visiting the mosques, the abundance of daylight elements has been taken and it was revealed that sunbreaker, lattice doors and windows, coffering, and grille have had the highest abundance among the daylight elements (Table 4).

Table 4. Light-catching elements abundance in Qajar mosques in Shiraz.

Light-catching elements	Grille	Lattice doors and windows	Sash window	Opening	Goljam	Fakhr-o-Madin	Rose window	Frieze and Pulvino	Coffering	Muqarnas	Vestibule	Portico	Sunbreaker	Jam Khaneh	Horno	Roshandan
abundance	146	255	35	19	8	65	29	0	153	22	5	12	384	0	4	0

5. Quantitative analysis

According to Table 3, the analysis of Light-catching elements' number and abundance in different geographical directions in Qajar mosques in Shiraz can be processed.

In the below mentioned graph, the overall numbers regarding the percentages of the usage of each luminaire element at Qajar mosques in Shiraz has been generally illustrated which is obtained by dividing the number of each element in the entire mosque into the total number of lightening elements.

The abundance of elements was investigated and analysed in three categories of light-catchers, light controllers, and light reflectors. As it can be observed, in light-catchers category, the highest abundance belongs to the 'Lattice doors and windows' and the 'Grille, Fakhr-o-madin, Sash window, Rose window, Opening, Goljam and Horno' are represented. In the light controllers' category, the highest abundance belongs to 'sunbreaker' and subsequently 'Portico' is the next one. In light reflectors category, the highest frequency is related to the 'coffering' element (Figure 1).

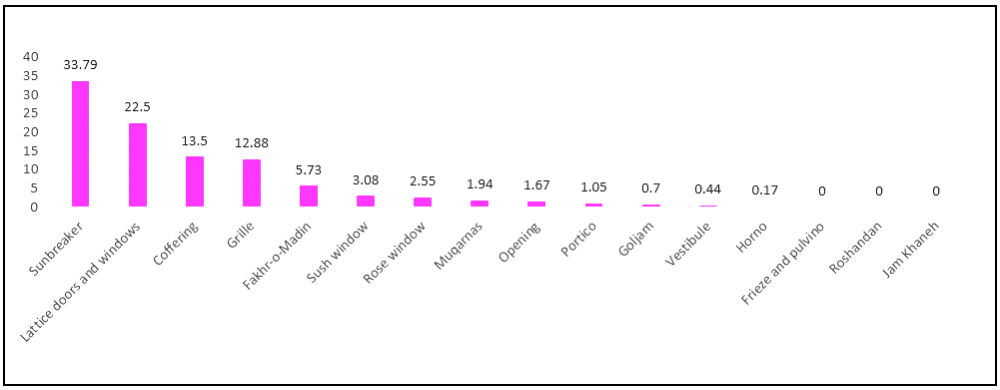

Figure 1. Average usage percentage of each light-catching element in samples of Qajar mosques in Shiraz.

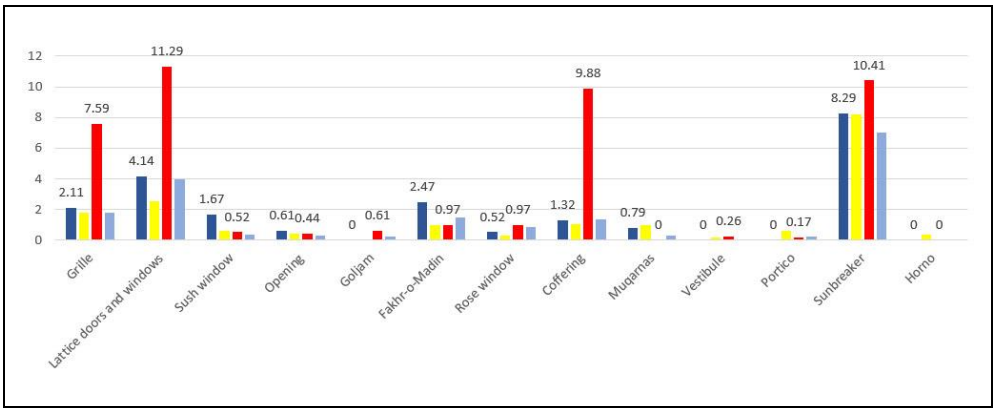

Figure 2. The comparison of light-catching elements in the four geographic directions.

Figure 2 compares the light-catching elements from the geographical direction aspect and is calculated from dividing the number of each light-catching element to each geographical front with means of the total number of light-catching elements in all samples. This diagram demonstrates that the

amount of utilization of lightning element on the southern front is sunbreaker, Lattice doors and windows, and Grille and on the Eastern front is Lattice doors and windows, sunbreaker, and Coffering, respectively. On the western front, it is sunbreaker, Lattice doors and windows, and Grille.

By the notion of the data which is represented in this diagram, this question can be answered which implies whether there is a logical and meaningful connection between the geographic direction and the climatic function of an architectural element regarding daylight.

According to the studies, the highest rate for using light-catchers in Qajar mosques in Shiraz is related to the eastern and southern fronts, where among them, the most light-catchers' abundance in all these directions belongs to 'Lattice doors and windows'. It seems that because of the physical and spiritual importance of light presence in the mosque, this element with a high light transmission intensity, is used in all directions, and its light transmission amount is controlled by sunbreaker (sunbreaker embers the highest abundance among light controllers in addition to all of the light-catchers).

The 'Grille' element possesses the second rank from the aspect of abundance. However, this element was more utilized on the eastern front, in comparison to other fronts. This is because it is justifiable and numerous numbers of light-catchers are located in this direction by playing the role of controlling light. Although, Goljam hasn't been used in North and South Fronts, this element is observed on the eastern and western fronts where it is required to adjust light colours (The coloured glasses of Goljam control the intensity and the colour of the transmitted light). 'Sash window' and 'opening' are more abundant in the north, with a moderate frequency in the south and east, and less frequency in the west. This arrangement allows unity and permits the appropriate light of to get into the space. Additionally, it moderates the south and east lights, and it reduces the amount of inappropriate light to enter from the west. Abundance of Fakhr-o-madin and Rose window indicate the low attention of the climate factors from the aspect of the elements' location in the building. Hence the element 'Fakhr-o-madin' (with moderating role) has the highest frequency in the northern and western fronts respectively. Also, 'Rose window' is the most frequent window element on the eastern and then western fronts. However, the presence of 'Fakhr-o-madin' in the north front, which provides a uniform and suitable light, is not necessary. Indeed, it is better that 'Rose window' (with moderate transmission of light) get omitted from the western front (which is unsuitable for lighting). The 'portico' element has the highest abundance in the south and west fronts for the purpose of shadowing, respectively, and the north front with low and uniform light lacks 'portico'. In researches of light reflectors, it is observed that while the 'vestibule' element is used on south and east fronts (which helps adjusting the intensity of light and uniformity of space), it is not applicable in the north (with uniform light) and the west fronts (with inappropriate light). 'Muqarnas' is the most abundant element in the south front and possesses the lowest abundance in the west front. Coffering abundance in

different light-catching fronts is observed in the eastern, western, northern and southern fronts, respectively.

6. Conclusions

In Iranian climatic architecture, at the southern fronts of the building, there is a need for awning in order to control the light intensity for the purpose of allowing proper light which is going to be entered into the space in winter; In addition, it is associated with reducing the light intensity which enters into the space in summer and it controls the inappropriate light and its direct radiation in west.

By the notion of the findings of this study, it was revealed that because of the high intensity of light on the southern front of the building , and also, because of the inappropriate light of the western front, the ratio of 'controllers' to 'light-catchers' possesses the highest amount, which indicates that there is more attention of light controlling on these two fronts. However, on the east front, because of the short duration of light-catching and on the north front due to the unity and proper light, this ratio embers the lowest amount which is justifiable as it requires less amounts of controlled light on these fronts. The proper use of light controllers such as 'Portico' in the south (with high light intensity) and west (with inappropriate light) fronts, in addition to the utilization of light-catchers with proper light transmission level like 'Sash window' and 'Opening' in north front (with proper and uniform lighting), illustrate the climatic consideration of Qajar mosques' architectures in Shiraz. Thus, by the notion of the intelligence which was conducted in choosing the type and orientation of architectural elements regarding daylight and their proper placement in the architectural body of mosques, it can be concluded that the Iranian architects have not just create a spiritual and mystical space, but also they have paid especial attention to climate comfort for the worshipers' which are worshiping inside the mosque. To sum up it can be mentioned that, by reducing the light in some places, the Iranian architect has directed the user's motion in a way that it can amplify the motion of light by the light source. In fact, the light here plays a conductive role. Meanwhile, in another places, by reducing the light, architect makes the mosques' space attractive, as instance, Iranian architect makes it vestibule in a way that it's limited and controlled light is provided by the lattice window of courtyard, which creates an obscure view of the courtyard that represents mobility and curiosity to the viewer. After all, the appropriate categorization of light elements into three categories: controllers, light-catchers and reflectors demonstrates the delicate intelligence which was implemented at these places.

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