

Recognition of light-openings in Iranian mosques' domes With reference to climatic properties

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Abstract

Mosque architecture is considered as a potent visual symbol of the Islamic architects' design ability. Prayer-hall as the manifestation of equality between the believers and the unity of architectural space has challenged such an ability throughout the history. This study, considering the characteristics of light-openings in the domes of Iranian mosques' Prayer-hall, aims to investigate these domes' possible relationship with the climatic features of each mosque. To this end, eighteen case-studies according to the research analytic approach are studied to determine: 1. the relationship between the mosques construction period (Iranian architecture styles) and its light-openings number on the one hand and its climatic features on the other hand, 2. The relationship between the light-openings' location and the climatic features of each mosque, 3. The relationship between the light-openings' number and the climatic feature of each mosque and finally, 4. The relationship between the prayer-hall's height and the number of light openings of each mosque on the one hand and its climatic feature on the other hand. The study shows that Iranian architects have given considerable priority to the natural ventilation function of the light-openings, So, what used to be considered as the domes' main function, allowing the light to the interior space, is considered as their secondary function.

Keywords: Light-opening, Light, Natural ventilation, Hot-dry climate, Cold climate, Mosque prayer-hall

1. Introduction

Light has had a very prominent significance in Iranian beliefs throughout the history. Insistence on sanctity of life originates from the religious doctrines of the pre-Islamic era (Zoroastrian beliefs) which was emphasized in the Islamic era and, especially, Islamic Sufism. The light's consideration in Zoroastrianism sounds clear in Ashvzrtsht's statement: "Because God or Total Light is hidden form the head-eyes, we should notice the concrete light to incline our spiritual conscience to the spiritual light or Ahura Mazda" [1]. Light has special importance in Quranic verses too: "God is Light of heavens and earth (Noor, 35). Moreover, Prophet Mohammad has added a cosmological aspect to the mentioned verse: "The first creation of God was Light" [2]. A special branch of philosophy called "School of Illumination" which is based on

the light analogy was founded by Shahab al-Din Suhrawardi and expanded by Ghotb al-Din Shirazi, Mulla Sadra and others. According to Suhrawardi, Iranian and Arabic literature, and even, everyday dialects, are full of descriptions, assuming light to be the same as spiritual exhilaration and proper function of reason. these all, are base on defining light synonymously with truth and happiness. Such an analogy has been established in the Islamic customs and traditions; although, some of the older religious rituals, especially, Mazdaism had acknowledged it too [2]. Overall, in most religions, light is the symbol of Divine Wisdom and the element of all goodness and purity; so going from darkness to light has been the main goal of life [3].

Since the religion, mysticism and culture, throughout the Iranian history, have always been in direct relationship with the architecture of each era, the Iranian architecture has always strived to give the interior a kind of spiritual atmosphere. moreover, since no other sign symbolizes or is manifestation of divine unity as light is, Divine Unity, Islamic artists have strived to use the it in their works to make them much closer to the source of spirituality [4]. Thus, Islamic architecture atmosphere, as one of the prominent emanations of the artistic truth through the materialistic object [5], is saturated with the visual and spiritual effects of light. Such effects have been applied by the Iranian master-mimars to all

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parts of the buildings, especially, the mosques domes.

On the other hand, since the beginning Of the history, man has been affected by the climate and its influences. The primitive man-made shelters were built to protect their residents from the natural elements and considered to be the most obvious evidence of such a claim. Hence, the architecture with respect to the climatic features several thousand years of history. In fact, along with mankind's permanent resistance in a place, taking the climatic properties into consideration has played a pivotal role in building and design process. However, the first documentation of architectural design, with the climatic interests in mind, dates back to the 1st century BC. Greece. Vitruvius (born c. 80–70 BC, died after c. 15 BC), a Roman architect and the author of the celebrated treatise *De architectura* (on Architecture) wrote: "We must, at the outset, take note of the countries and climates in which buildings are built"[6].

Overall, a building should be built in a way which is suitable with the climate, because it becomes a part of the nature (i.e. a tree or stone) once it is constructed. This means that it is exposed to the effects of sun, rain and wind like any other object in the nature. Obviously, climatic balance was taken into account in most traditional architectures including the Islamic-Iranian architecture [7]. A review of many Iranian historic towns and villages' architecture shows that one of the factors affecting such regions architecture is the adaptation of architectural features with the climatic and environmental properties of each region. The architects who apply the climate-responsive architecture are to take the utmost advantage from the surrounding environment and the average climate conditions of each region. The architectural characteristic differences of various climatic regions including the hot, dry, cold, temperate and humid regions, ... shows that Iranian architecture, as a climate-responsive architecture, applies special technical strategies to take the most advantage out of the natural environment and to create a favorable environment for the human life, providing the possibility of peaceful coexistence between human and his environment at the same time.

As mentioned in previous lines, there is an apparent relationship between Iranian architecture, especially the Islamic-Iranian one, and significant necessity of light on the one hand and the crucial effective role of the climate on the other hand. By the same token, embedding the double-function openings in some parts of a building to meet the structural requirements, supplying the light and thermal comfort at the same time is considered as a smart strategy adopted by the Iranian master-mimars. This study is to determine the priority of one of the two discussed functions in the mosques, as the most prominent Iranian buildings, through comparative-analytic reviews of the light-openings' characteristics located in the mosques' prayer-halls.

2. Light-openings in Iranian mosques

Mosques and the way they bring the light in, is not the same as other religious temples. For example, in Hindu temples, it is believed that the path of love and self recognition are recognized in the darkness, because when there is no light, nothing is seen; and therefore, there will be nothing distracting people from themselves [8]. In contrast to such ideology, in Islamic thought, Allah is Light and all the creation is from the divine Light. The

way the light is seen in the mosques or other Islamic spaces is a path which is from the darkness to the light, but this light is never distracting, because it is the origin of life. Furthermore, In Islamic thought, light plays an influential role not only in the spiritual relationship between the believers and the religion, but also between the believers and the building. Such a role is much more apparent in the mosques, taking a leading part in the creation of a spiritual or an aesthetical atmosphere. In other words, while the building's structure forms the religious environment, the light forms the religious experience.

Iran, as an Islamic country, has variegated the mosques in different cities which are all designed in a way to have a special light-oriented structure. To this end, using different openings and apertures around the mosques' domes or in the prayer-halls' walls, due to the mystical and structural objectives, is very prevalent. According to the Iranian architectural principles, an opening is a vent embedded in the wall or ceiling for allowing the air or the light in [9]. Hence, each opening has two significant functions including increased sunlight and air penetration to the interior, leading up to natural ventilation and lighting of the interior.

In the early years of domes' construction in Sassanid dynasty or the early Islamic era, only the oculus was used to allow the light or air penetrate the inner space of a building, but after achieving more developed structural techniques to distribute the structural forces or tensions by the Iranian master-mimars, the light-openings were located at 4 definite points: 1- The dome's top, 2- the dome's curve, 3- the dome's shekargah, 4- the dome's drum [10] (Fig.1&2). The light-openings located at the prayer-halls' walls could be added to the previous list. The hypostyle prayer halls with the large openings in the walls which maximize the penetration of both direct and reflected sunlight were installed at the mosques to express the equality between the believers and to point out the unity of the architectural space.

3. Climates of Iran

There are different geographical areas in Iran creating variety of climates with special characteristics. Iran is basically divided into four climatic regions: Moderate-Humid, Cold, Hot-Humid and Hot-Dry Climate [11]. Such diversity in climates have considerably affected the urban planning and architecture in a vast country like Iran, leading to a series of technical solutions for the human comfort, adopted by the traditional master-mimars. The significant principle for the buildings' construction in any climatic area is the need for a better environmental condition. According to Fathy, early man built the houses to keep out the

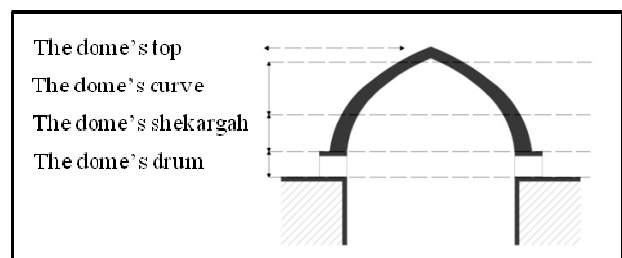


Fig. 1. The different areas to locate the light-openings in the Iranian domes The light-opening in the drum area [10]

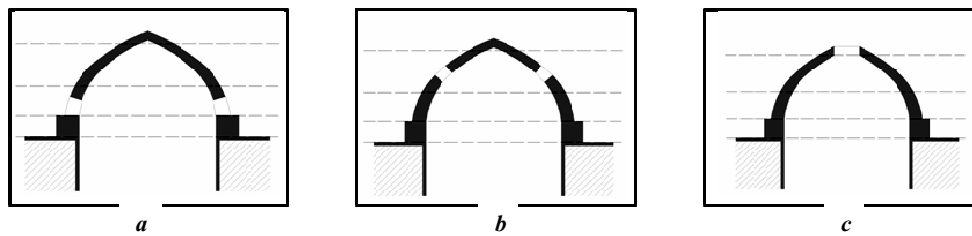


Fig. 2. a) The light-opening in the Shekargah area, b) The light-opening in the curve area, c) The light-opening in the top area [10]

elements – rain, wind, sun and the snow. His purpose was to produce an environment suitable for his comfort and even for his survival [12]. Hence, there is a direct relationship between the architectural and climatic features of each region.

To study the possible relationship between the light-openings, the amount of captured light in mosques' prayer-halls and climatic conditions, climatic data is limited to the number of hours in a day and the thermal comfort features during the days. For this reason, average maximum temperature is considered for summer and winter in different climates. Also, the research domain is limited to the cold and hot-dry climatic areas due to their vast all-climatic zones, and hence, the research case-studies are selected from among all the main mosques located in such climatic regions.

3.1. Hot-dry Climate: this climate includes most parts of the central Iranian plateau, which receive almost no rain for at least six month of the year. The summer is very hot and dry and the winter is very cold and hard. Generally in this study, the hot-dry climatic zones include those geographical areas where staying protected from the winter's coldness and the summer's heat of great significance.

Hot-dry climate includes two different geographical regions: plain region and the desert region. In the plain region, the average maximum temperature in summer days is about 35° to 39° and in winter days is about 9° to 16°. Moreover, such a region is sunny %55 of the time in winter days and %80 in summer days. people in such regions need to stay protected from the winter's cold for one fourth of the year and do the same for half the year from the heat of the summer. Since in plain regions, about 5 to 6 months of a year there is not enough shadow, the comfort condition is provided through the appropriate constructive materials, air flow and Cooling via water evaporation.. Furthermore, the heat exchange should be controlled by the walls and taking the most advantage from the sunshine during the cold days while benefiting from the cool winds and breezes during the hot days. [13].

In desert regions, the average maximum temperature in summer days is about 37° to 44° and in winter days is about 12° to 20°. This region is sunny %60 of the time in winter days and %88 of the time in summer days. In such regions, staying protected from the extreme heat and dryness, hot or dusty winds and coldness of the winter is inevitable. Furthermore, there is not enough shade for about 6 to 7 months of the year; hence, like the plain regions, the comfort condition is provided through the appropriate constructive materials, air flow and Cooling via water evaporation. In desert regions, Staying protected from the coldness of the winter for one-fifth of the year and the hotness of the summer for two-third of the year is inevitable [13].

3.2. Cold Climate: The cold climate consists of the west slopes of the central mountain chains of Iran. All over of this area, from Azerbaijan to Fars, winter is long, hard and cold, and throughout several months of the year, ice covers the area. Generally, in this study, the cold climatic zones include those geographical regions where staying protected from the winter cold has more significance than doing the same thing from the summer heat.

Cold climate includes three different geographical regions: the mountainous, the altitudes' foot-hill and the medium altitudes' foot-hill regions. Regarding the human comfort in the summer days, the weather is pleasant in the mountainous area and relatively warm in the altitudes' foot-hills. To supply the thermal comfort during the hot seasons in the mountainous areas, only the use of shades seems effective enough, but in the altitudes' foot-hill region, utilizing the appropriate construction materials seems extremely necessary. Since staying protected from the coldness of the winter in the cold climate region, in most days of the year, is inevitable, the heat loss through the walls should be minimized and the sunlight should be used advantageously.

The average maximum temperature in the winter days is about 2° to 13°; while in the summer days it is about 28° to 35°. Such a region is sunny %40 of the time in winter days and %80 of the time in summer days.

In medium-altitudes' foot-hill areas, including Qazvin and Mashhad, the average maximum temperature during the summer days is about 31° to 38° and in winter days is about 7° to 17°. Furthermore, such an area is sunny %55 of the time in winter days and %80 of the time in summer days; hence, throughout the year's hot seasons (about 4 to 5 months), around the noon, supplying the thermal comfort just through the shade is obviously insufficient and the utilization of appropriate construction materials, the airflow and the evaporation cooling is very appropriate [13].

4. Research mechanism

4.1. Research Goals: analysis of the relationship between the climatic features of each mosque which is located in various geographical regions and its light-openings' characteristics.

4.2. Research Questions: is there a meaningful relationship between the light-openings' characteristics and the climatic features of Iranian mosques?

4.3. Research method: The research is based on adopting the case-study and combined strategies [14] along with the descriptive-analytic and comparative-analytic tactics. Library research method is applied as the data gathering method.

4.4. Research Case-studies: eighteen mosques, especially Jame mosques, located in the hot-dry or cold climatic areas from among all the considerable research cases are selected.

5. The case-studies

5.1. Hot-dry Climate Mosques

5.1.1. Saveh Jame' Mosque: Based on some inscriptions, mosque constructed in 504 AH during Mohammad-ebn Malek Shah Saljuqi period coinciding with the establishment of the city itself [15]. Around fourth or fifth century, a prayer-hall was constructed in the mosque's south front [9] (Fig.3).

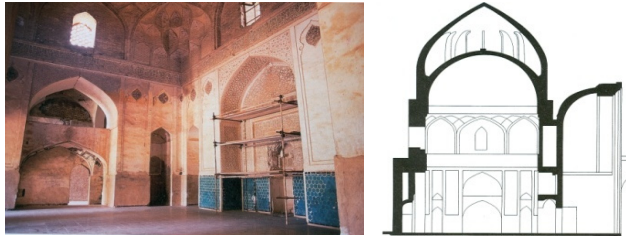


Fig. 3. Saveh Jame' Mosque, a. the prayer-hall [9], b. the prayer-hall section [9]

5.1.2. Ardestan Jame' Mosque: Some parts of the mosque was constructed in accordance with Khorasani style (1th AH – 4th AH), as one of the traditional Iranian architectural styles, and some other parts such as the southern iwan and the prayer-hall have been constructed in accordance with Razi style (4th AH – 6th AH)[16] (Fig. 4).

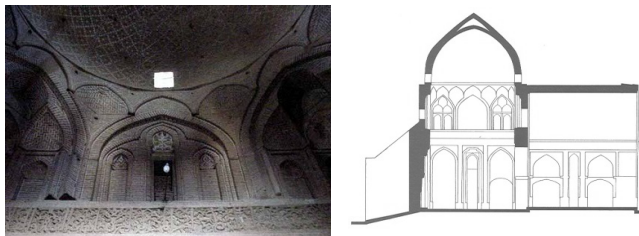


Fig. 4. Ardestan Jame' Mosque, a. the prayer-hall (the authors), b. the prayer-hall section [9]

5.1.3. Zavareh Jame' Mosque: According to the researchers, the current mosque was constructed in 6thAH by Iranian master-mimar Mohammad Reza Isfahani which might has been reconstructed on the remains of the former mosque [16] (Fig.5).



Fig. 5. Zavareh Jame' Mosque, a. the prayer-hall [9], b. the prayer-hall section [9]

5.1.4. Varamin Jame' Mosque: The mosque was constructed

in IlKhanid dynasty under the command of Shahrokh Timurid. In the mosque's prayer-hall, there is an inscription pointing the date of 726 AH out [9] (Fig. 6).

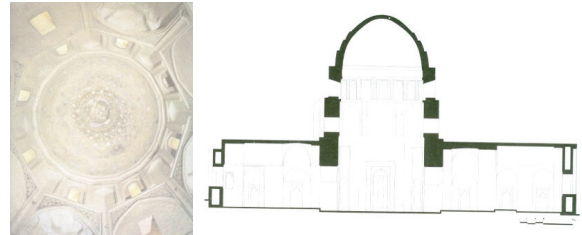


Fig. 6. Varamin Jame' Mosque, a. the dome interior [9], b. the prayer-hall section [9]

5.1.5. Qom Jame' Mosque: The mosque was constructed during several historical periods. The mosque was erected by Toghrol, the Iranian king of Saljuqi dynasty, in 528 AH. According to Andre Godard, the original building dates back to 3th century, whereas the oldest part is related to the Saljuqi era [9] (Fig. 7).

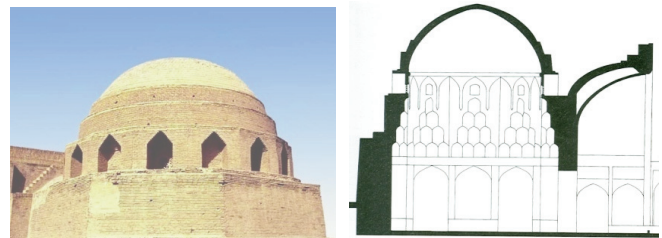


Fig. 7. Qom Jame' Mosque, a. the dome exterior (the authors), b. the prayer-hall section [9]

5.1.6. Yazd Jame' Mosque: The construction process started at 724 AH [17]. It was first built under the command of Ala'oddoleh Garshasb of the Al-e Bouyeh dynasty (Fig. 8).

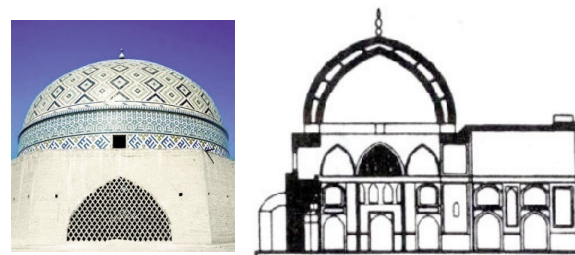


Fig. 8. Yazd Jame' Mosque, the dome exterior (the authors), b. the prayer-hall section [16]

5.1.7. Isfahan Imam (Shah) Mosque: Imam Mosque, built during the Safavid period, is an excellent example of the Islamic architecture of Iran. According to Pirmia, the construction process started in 1020 AH by one of the brilliant Iranian master-mimars, Ali Akbar Isfahani[16] (Fig.9).

5.1.8. Isfahan Sheikh Lotf Allah Mosque: Sheikh Lotf Allah Mosque is one of the architectural masterpieces of Safavid Era Iranian architecture. The construction of the mosque started in

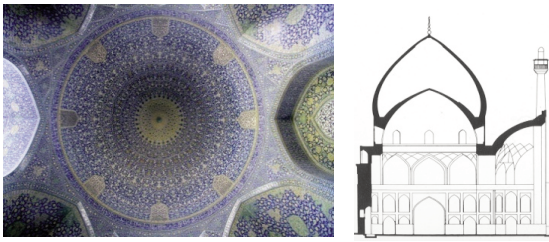


Fig. 9. Imam mosque of Isfahan, a. the dome interior [9], b. the prayer-hall section [9]

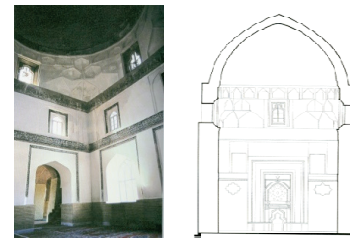


Fig. 12. Orumieh Jame' mosque, a. the prayer-hall [9], b. the prayer-hall section [9]

1012AH and was finished in 1028 AH. It was built by the chief architect Shaykh Bahaiand, and the brilliant master-mimar Mohammad Reza Isfahani during the reign of Shah Abbas the 1st of the Safavid dynasty[16] (Fig. 10).

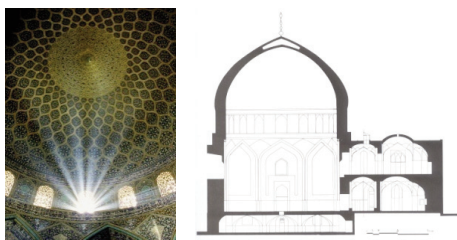


Fig. 10. Sheikh Lotf Allah mosque of Isfahan, a. the prayer-hall (the authors), b. the prayer-hall section [9]

5.1.9. Isfahan Agha Bozorg Mosque: The mosque was built in 1268 AH, in Qajar era, by Iranian master-mimar Ustad Haj Sa'ban-ali. Agha Bozorg Mosque was constructed for prayers, preaching and teaching sessions held by Molla Mahdi Naraghi, known as Agha Bozorg [17] (Fig. 11).

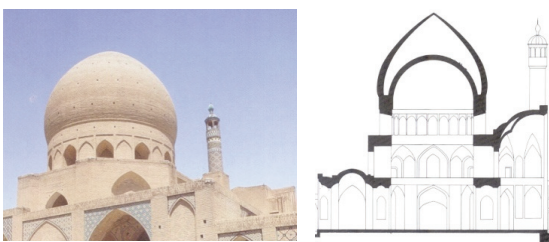


Fig. 11. Agha Bozorg mosque of Kashan, a. the dome exterior (the authors), b. the prayer-hall section [9]

5.2. Cold Climate Mosques

5.2.1. Orumieh Jame' Mosque: The mosque's building consists of several parts constructed or reconstructed in various historical periods. The ancient dome of this mosque is dated back to the period of Saljuqians and its altar to the Eilkhanian era in 676 AH. Its inscription, also, indicates the date of construction in 1184 AH. The new parts have been constructed in the recent decades [9] (Fig. 12).

5.2.2. Golpayegan Jame' Mosque: Based on the inscription beneath the dome, the mosque's prayer-hall was constructed during the Seljuk Sultan Muhammad's Era (1105 AH-1118

AH). The prayer-hall's building, as the only remained part of the original mosque, was integrated into a monumental four-iwan mosque during the Qajar period [9] (Fig. 13).

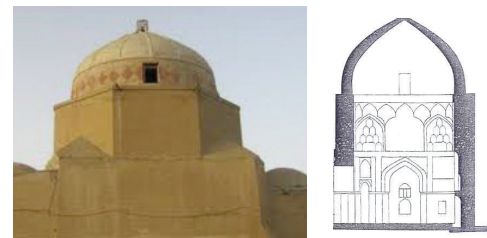


Fig. 13. Golpayegan Jame' mosque, a. the dome exterior (the authors), b. the prayer-hall section [9]

5.2.3. Qazvin Jame' Mosque: The original part of the mosque was constructed during the early centuries of the Islamic Era. The current prayer-hall's construction started in 500 AH by the order of Amir Khomartash, and along with other parts, finished in 509 AH. The last additions were built during the late Safavid Era [9] (Fig. 14).

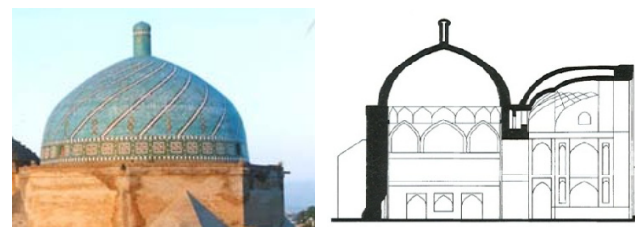


Fig. 14. Qazvin Jame' mosque, a. the dome exterior (the authors), b. the prayer-hall section [9]

5.2.4. Kaboud Mosque of Tabriz: Kaboud Mosque, known as the Turquoise of Islam in its own time, was constructed in 870 AH. Its original dome was destroyed by an earthquake and reconstructed by Ostad Reza, one of the most brilliant master-mimars of Tabriz, according to the remains of the former dome [16] (Fig. 15).

5.2.5. Goharshad Mosque: The mosque was built by the order of Queen Goharshad, the wife of Shah Rukh of the Timurid Dynasty, in 821AH. The architect of the edifice was Ghavameddin Shirazi with the architectural and decorative manpower supplied from Shiraz and Isfahan. The mosque underwent some renovations during the Safavid and Qajar Eras [9] (Fig. 16).

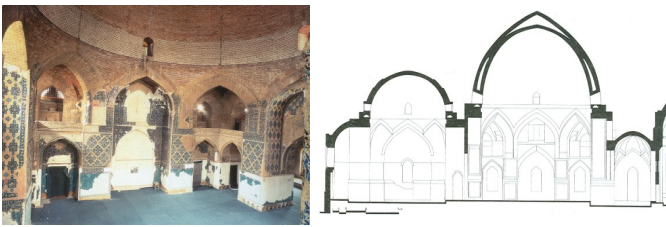


Fig. 15. Kabood mosque of Tabriz, a. the prayer-hall [9], b. the prayer-hall section [9]

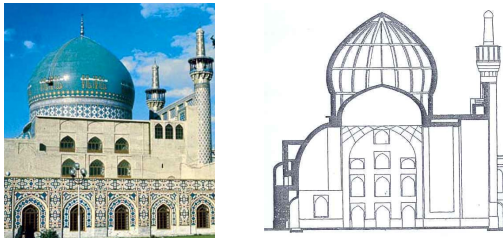


Fig. 16. Goharshad mosque of Mashhad, a. the dome exterior (the authors), b. the prayer-hall section [9]

5.2.6. *Zanjan Jame' Mosque*: The Mosque, also known as Seyed Mosque or Sultani Mosque was erected during the Qajar Era by Abdollah Mirza, the eleventh offspring of Fathali Shah of Qajar Dynasty in 1237 AH [9] (Fig. 17).

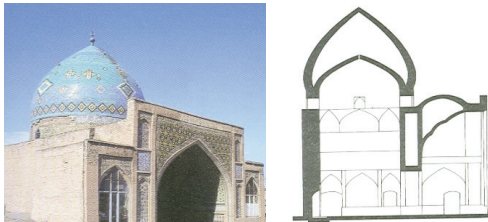


Fig. 17. Zanjan Jame' mosque, a. the dome exterior [9], b. the prayer-hall section [9]

5.2.7. *Hamadan Jame' Mosque*: the mosque's current building was constructed in Qajar Era. According to the southern iwan's inscription, the construction process started in 1253 AH, and most likely, at the age of Fath Ali Shah Qajar or at the beginning of Mohammad Shah Qajar[9] (Fig. 18).



Fig. 18. Hamadan Jame' mosque, a. the prayer-hall [9], b. the prayer-hall section [9]

5.2.8. *Borujerd Jame' Mosque*: Jame' Mosque of Borujerd was built on an ancient fire-temple of the pre-Islamic Sassanid dynasty. There is an order attributed to Shah Abbas Safavid II

on the mosque's western entrance pointing to the date of 1202 AH. In the current decades, its dome was rebuilt [9] (Fig. 19).

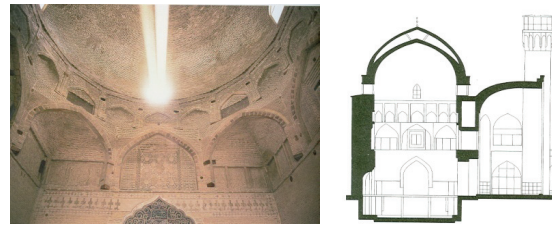


Fig. 19. Borujerd Jame' mosque, a. the prayer-hall [9], b. the prayer-hall section [9]

5.2.9. *Shahrekord Jame' Mosque*: there is a brick inscription on the mosque's exterior wall pointing to the date of 1270 AH. The mosque's benefactor was Haj Mohammad Reza Khan Sotoodeh [9] (Fig 20).

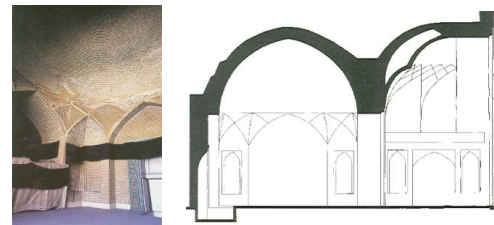


Fig. 20. shahrekord Jame' mosque, a. the prayer-hall [9], b. the prayer-hall section [9]

6. Discussion

In order to determine the relationship between the climatic features of each mosque which is located in various geographical regions and the light-openings' characteristics, eighteen case-studies, using analytic research approach, were analyzed. Then, through classifying the obtained analytic results, the research questions were to be answered.

To this end, the case-studies were studied to determine: 1. the relationship between the mosques' construction period (Iranian architecture styles) and its light-openings' quantity on the one hand and its climatic features on the other hand, 2. The relationship between the light-openings' location and the climatic features of each mosque, 3. The relationship between the light-openings' quantity and the climatic feature of each mosque and finally, 4. The relationship between the prayer-hall's height and the light-openings' quantity of each mosque on the one hand and its climatic feature on the other hand.

6.1. Iranian Architecture Styles, Climate and light-openings' quantity

According to Figure 21, in Khorasani period, minimum attention was paid to the light and light-openings' presence in the mosques' prayer-halls. Even in the hot-dry climate with the emergent need to the ventilation and thermal comfort, there are the least openings in the mosques. Generally, in Khorasani period there is no considerable difference between the mosques' light-opening quantity in each climatic region, especially, in the hot-

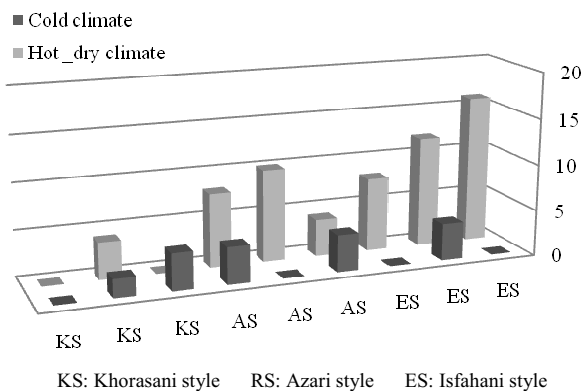


Fig. 21. The number of light-openings in the case-study domes of both climatic regions, regarding the Iranian architectural styles (the authors)

dry climate. Both of the discussed factors including the light and thermal comfort have been neglected. In Azeri and Isfahani period, the number of mosques' light-openings in hot-dry climate has significantly increased, whereas in cold climate; in spite of the passage of time leading up to the more developed constructive techniques, there are still the least number of light-openings. In Isfahani period, due to the prevalence of Illumination School of Suhrawardi, maximum light appeared in the mosques' interior to create a spiritual atmosphere for the prayers with reference to the sacred or symbolic features of light.

6.2. Climate and Light-openings' Location

According to Table 1&2, in both climatic regions, the light-openings are frequently located in the domes' drum; although, a few are located in the domes' shekargah. Overall, considering

the light-openings' location in the domes, there is no significant difference between the two mentioned climatic regions.

Regardless of the light-openings' location in the dome's main structure, there are some in the prayer-halls' walls too. Although in the cold climate when the constructors tended to locate the significant number of the light-openings in the mosques' prayer-halls, they preferred to locate them in the prayer-hall's walls which generally resulted in maximum use of sunlight in winter days and. However, because of the larger sun angle with the horizon, the heating effects are reduced in summer days.

6.3. Climate and Light-openings' quantity

Since the prayer-halls of mosques with the winter Shabestans are used only in the year warm seasons,

To obtain the research results, the climatic needs of both discussed regions should be considered just in the year's warm seasons. On the other hand, since in the cold climates during the year's warm seasons, the factor of coldness is eliminated, through the construction of light-openings in the prayer-halls, the advantage of light's spirituality can be taken optimally. However, based on the achieved results, the case is not the same for the warm climate mosques. hence there are less light-openings in the mosques' prayer-halls located in the cold climatic regions compared with the mosques in the warm climatic regions. In other words, the light significance in the cold climate prayer-halls is notably less than the warm climate ones. On the other hand, the thermal comfort of the cold climate, and especially, the altitude foothill regions inhabitants (Tabriz, Shahrekord, Orumieh, Zanjan, Hamadan, Boroujerd and Golpayegan) in the year's hot seasons are meet through the shades, and in some day hours, through the airflow. In such climatic regions, due to the prayer-halls' considerable height, a

Table 1. Characteristics of hot-dry climate mosques

Mosques	Iranian Architectural style	Domes Span(m)	Prayer -halls Height(m)	Light-openings Number		Light-openings Location
				Dome	Wall	Dome
Saveh Jameh Mosque	Khorasani	17	23	---	3	---
Ardestan Jameh Mosque	Khorasani	10	20	4	4	Shekargah
Zavareh Jameh Mosque	Khorasani	8	18	---	4	---
Varamin Jameh Mosque	Azari	10	25	8	2	Drum
Qom Jameh Mosque	Azari	13	23	10	---	Drum
Yazd Jameh Mosque	Azari	14	24	4	4	Drum
Imam Mosque of Isfahan	Isfahani	22.5	25	8	Over4	Drum
Sheikh Lotf Allah Mosque of Isfahan	Isfahani	19	25	16	Over4	Drum
Agha Bozorg Mosque of Kashan	Isfahani	10.3	18	12	Over4	Drum

Table 2. Characteristics of cold climate mosques

Mosques	Iranian Architectural style	Domes span(m)	Prayer -halls Height(m)	Light-openings Number		Light-openings Location
				Dome	wall	Dome
Orumieh Jameh Mosque	Khorasani	11	19	---	Over4	---
Golpayegan Jameh Mosque	Khorasani	11	23	2	---	Drum
Qazvin Jameh Mosque	Khorasani	16	26	4	---	Drum
Kabood Mosque of Tabriz	Azari	16	22	4	Over4	Shekargah
Goharshad Mosque of Mashhad	Azari	14	26	---	Over4	---
Zanjan Jameh Mosque	Isfahani	8	17	4	---	Drum
Hamadan Jameh Mosque	Esfahani	13	15	---	3	---
Borujerd Jameh Mosque	Esfahani	10	20	4	3	Drum
Shahrekord Jameh Mosque	Esfahani	7	10	---	---	---

few light-openings in the mosques' prayer-halls seem effective enough. So to provide the inhabitants thermal comfort, no more airflow is needed. As the result of this, the necessity of having more openings is neutralized.

In the semi-altitude foot-hills like Mashhad and Qazvin, the inhabitants' thermal comfort in the summer time is provided through the airflow and evaporation cooling in some hours of a day, as in Goharshad mosque in which, through the construction of several light-openings in the prayer-hall's wall, the prayers thermal comfort has been effectively provided.

To meet the inhabitants' thermal comfort through the natural ventilation in the hot-dry areas, considerable number of light-openings in the prayer-hall along with the prayer-hall's significant height is considered as an efficient strategy. In such areas, the mosques' light-openings are covered with screens decorated with arabesque or geometric designs to avoid the intensity of sunlight while taking advantage of the openings' natural ventilation function. In Agha Bozorg mosque, utilizing the large and numerous openings in the dome and the prayer-hall's walls, in addition to the gardens, are considered as the most efficient solutions to supply the building's evaporation cooling.

6.4. Prayer-hall's Height, Climate and Light-opening

Considering the size of mosques' prayer-halls, the prayer-halls' height as well as the size of the domes' spans in both climatic areas are approximately the same. Hence, one of the fundamental principles of the cold climate architecture, the lower ceiling height compared with the hot-dry climate, has been neglected. Such negligence, even in the mosques like Kaboud mosque or Golpayegan mosque, where their prayer-halls are used in all seasons, is apparent. As a result, there is no meaningful relationship between the cold climate features and the prayer-halls' height. It can be claimed that the prayer-hall's height is affected by the mosques' symbolic characteristics in addition to the political orientations of the rulers.

7. Conclusion

The relationship analysis between the climatic features of each mosque and its light-openings' characteristics shows that in spite of a direct relationship between the technological development throughout various architectural periods and the increase of light amount in the mosques' interior, the climatic considerations in the cold climate areas have led to the lack of increase in the light-openings' quantity. Moreover, there is no significant difference between two climatic regions, regarding the light-openings' location in the domes, but in the cold climatic regions, when the constructors tended to install significant number of light-openings in the prayer-halls, they preferred to install them in the prayer-hall's wall. Paying attention to the maximum temperature in cold climate where the temperature is lower than 38°, the thermal comfort of inhabitants is provided through the shades and in some day hours through the airflow. On the other side, maximum temperature in hot-dry climate reaches 44°. Therefore, there is not enough shade and the comfort condition is provided through the appropriate construction materials, air flow and water evaporation

cooling. As the result, in cold climate there is no limitation in number of the light-openings, but as it is seen in case studies, the light-openings' frequency from the hot-dry climatic regions to the cold areas is reduced. Finally, the height of the prayer-halls is not affected by the mosques' climatic features.

According to the research's main result, despite the historical, cultural and symbolic background of light throughout all Iranian historical ages, the Islamic Iranian architecture has taken the residents' comfort into consideration and provided the residents with sufficient thermal comfort. The climatic properties are considered as its apparent signs, so that the considerable priority has been given to the natural ventilation function of light-openings, compared with what is commonly assumed as their fundamental function, allowing penetration of the light to the interior.

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